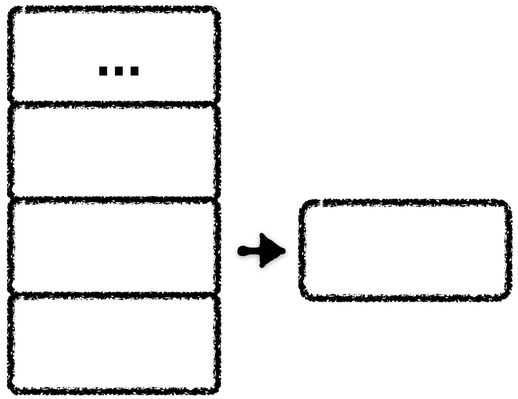
Tutorial on Concurrency & Consistency

CSC443H1 Database System Technology

Niv Dayan

Question 1 - Chained Hash Table Concurrency

Consider a chained hash table in storage subject to gets, inserts and deletes. Each node stores B fixed-sized entries, and overflows are handled using chaining. Deletes traverse a chain, removing the entry when they find it. Insertions traverse the chain, inserting an entry into a “hole” or add another node if there are no holes. Whenever a node runs out of entries, it is deleted.



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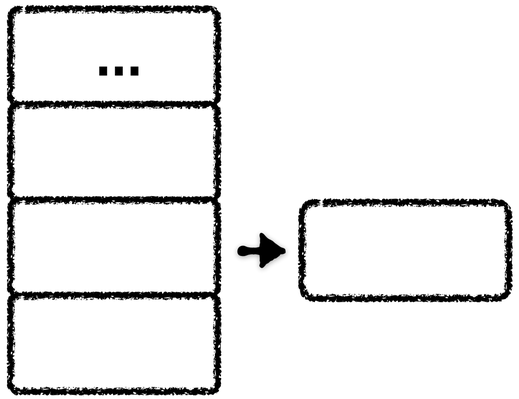

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(1) Is a chained hash table as susceptible as B-trees to locking contention? Why or why not? (2) Give an example where exclusively locking a whole bucket at a time for inserts/deletes can lead to contention? (3) How could you reduce this contention?

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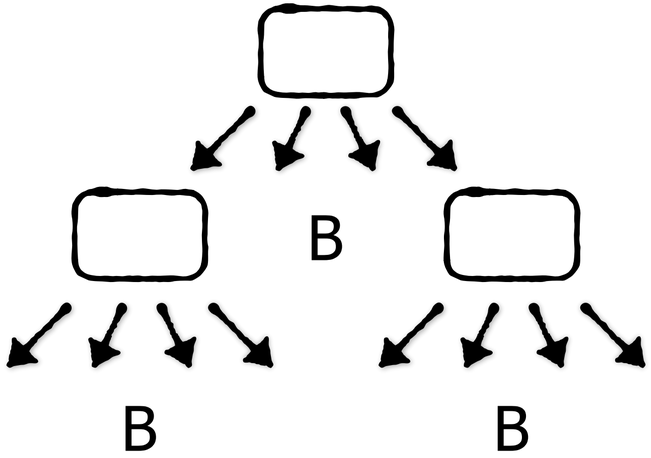
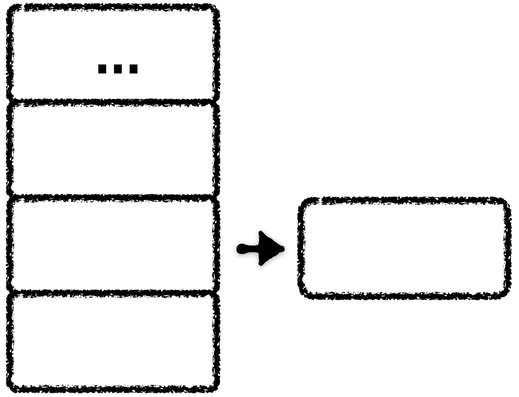
(1) Is a chained hash table as susceptible as B-trees to locking contention? Why or why not?

B-trees exhibit high contention at root and internal nodes since all accesses go through them.



Hash tables have uniform contention across buckets, so there is less blocking



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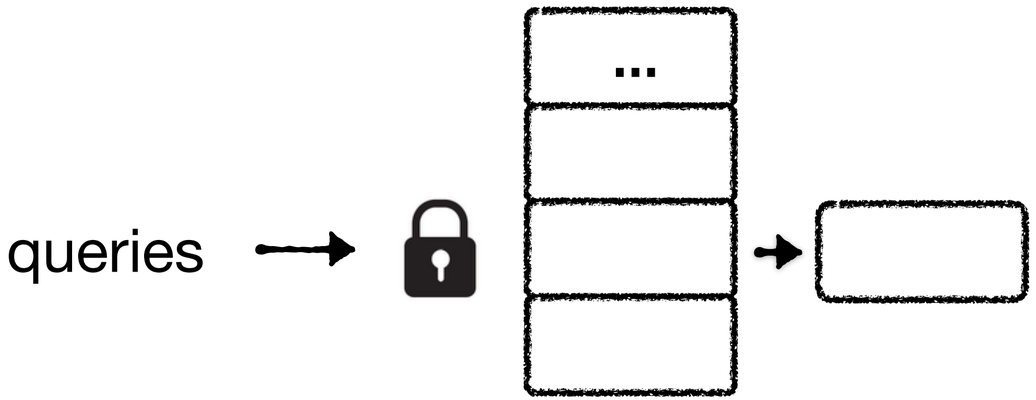
e.g., we have many insertions and deletions of the same key, so we exclusively lock the bucket over and over. All queries to other entries in the bucket are blocked.



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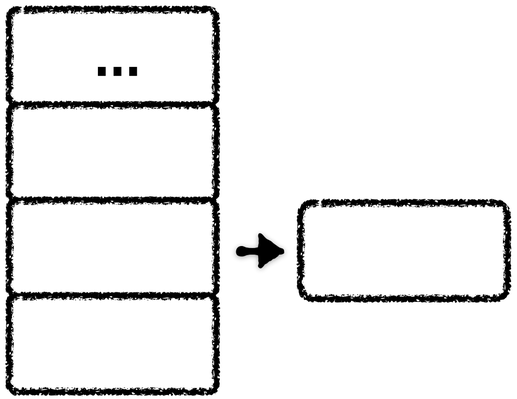

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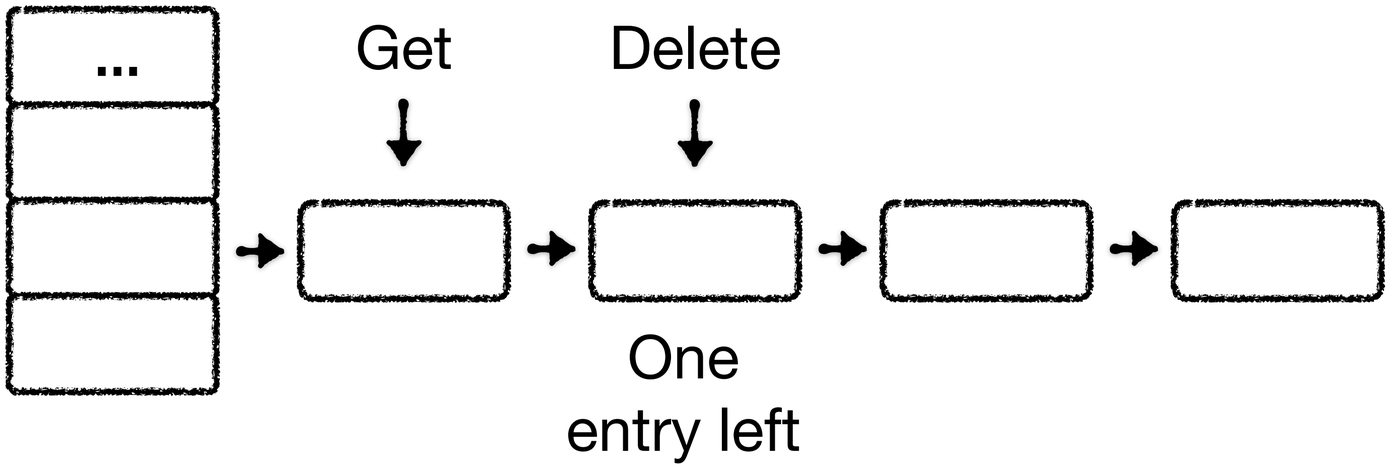

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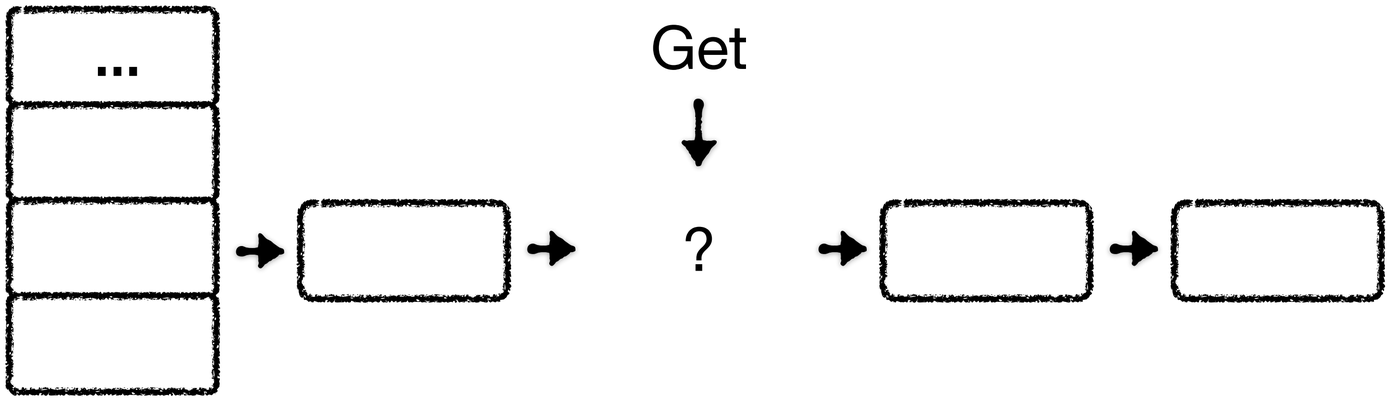

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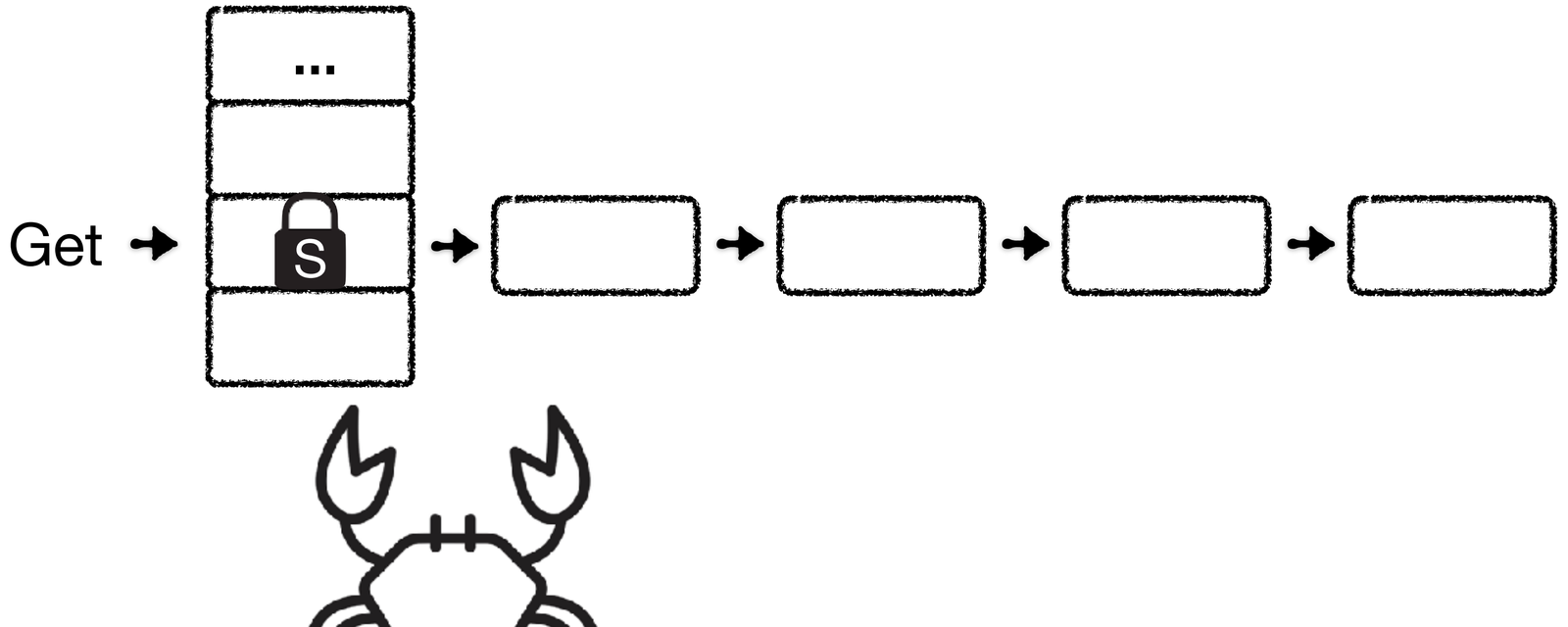

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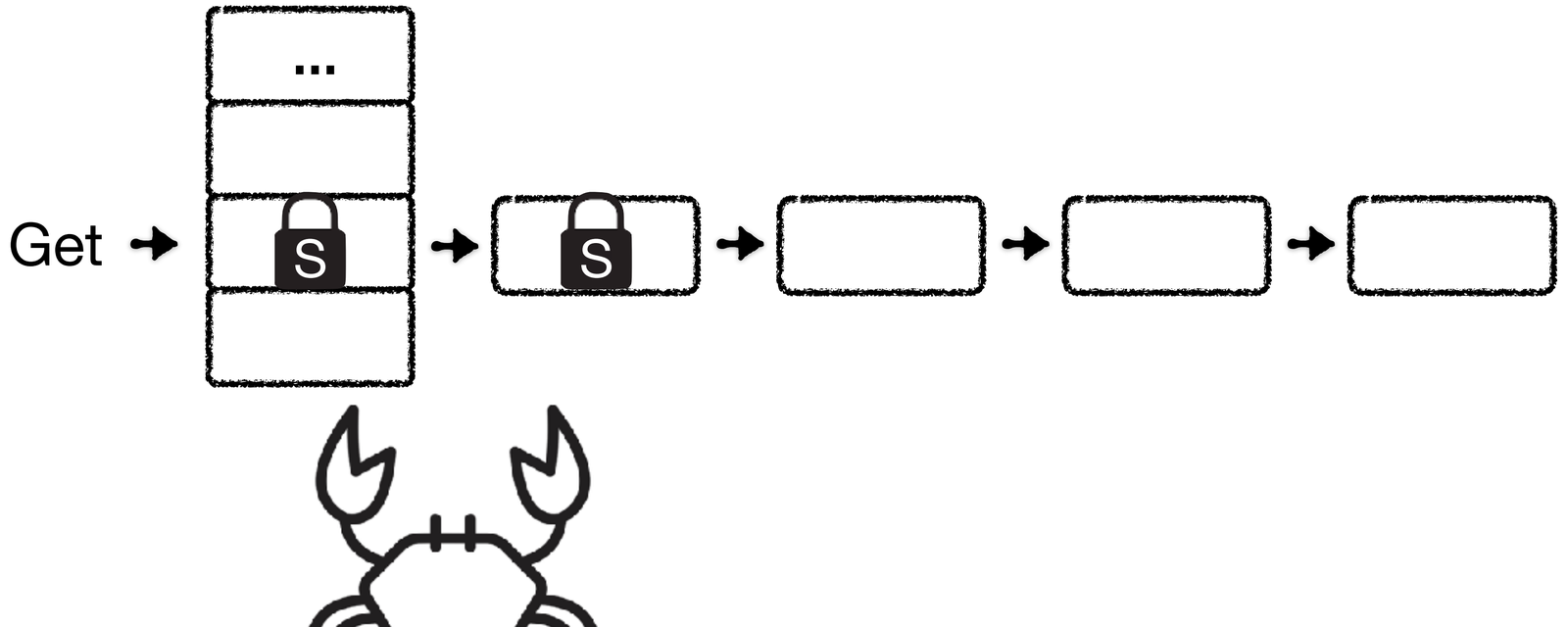

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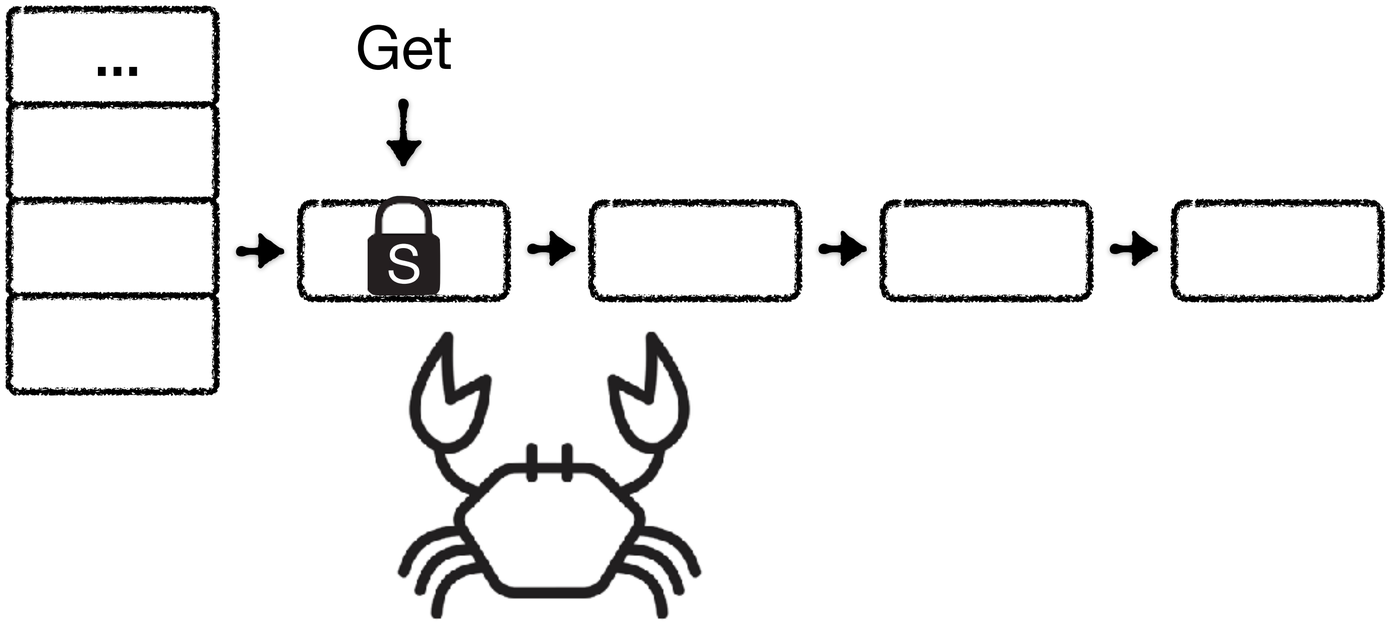

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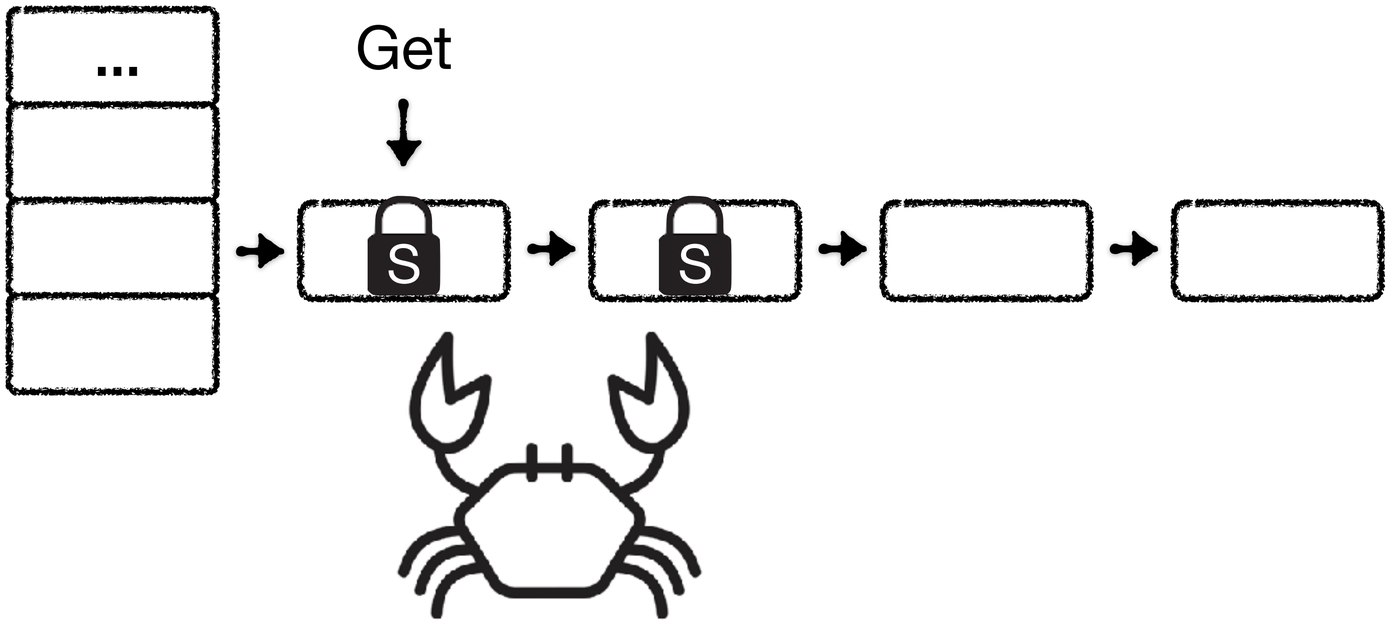

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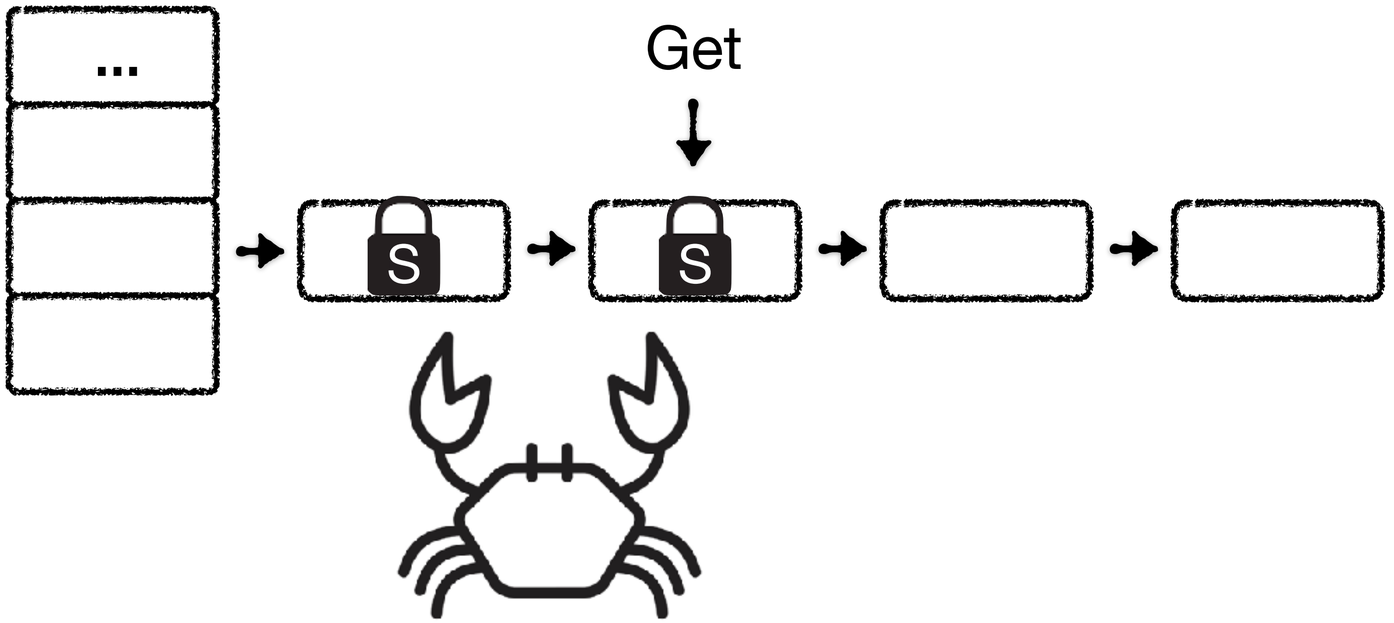

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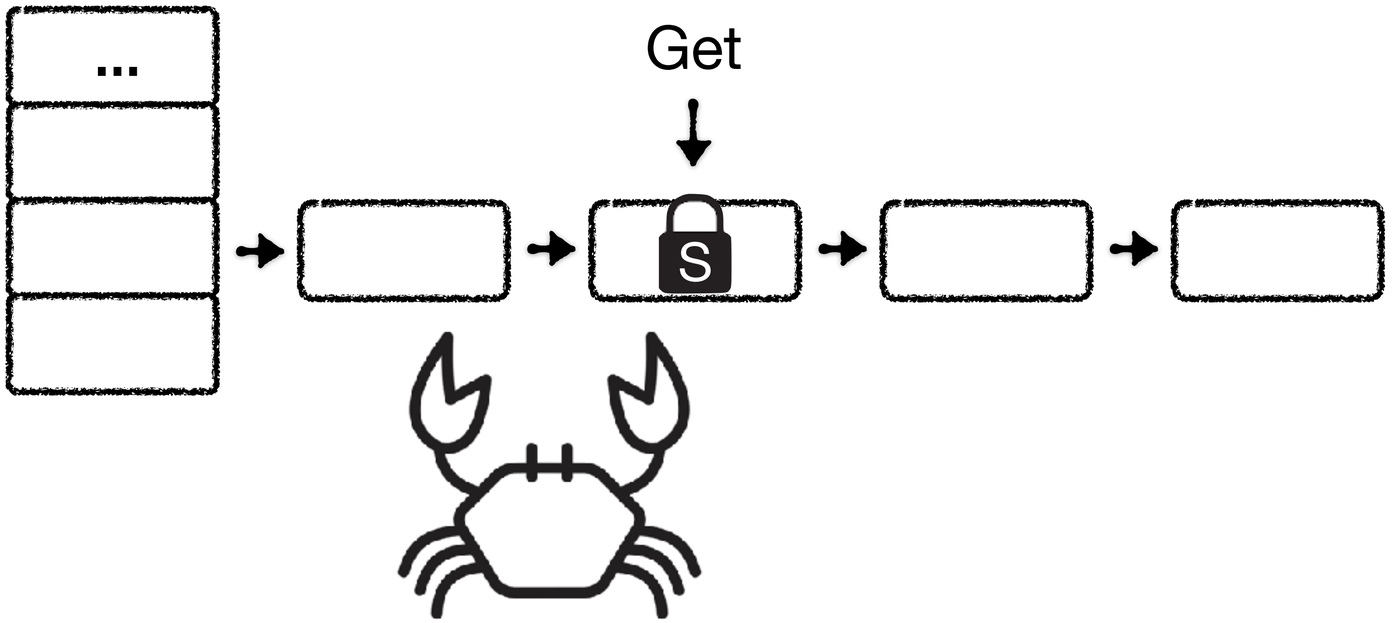

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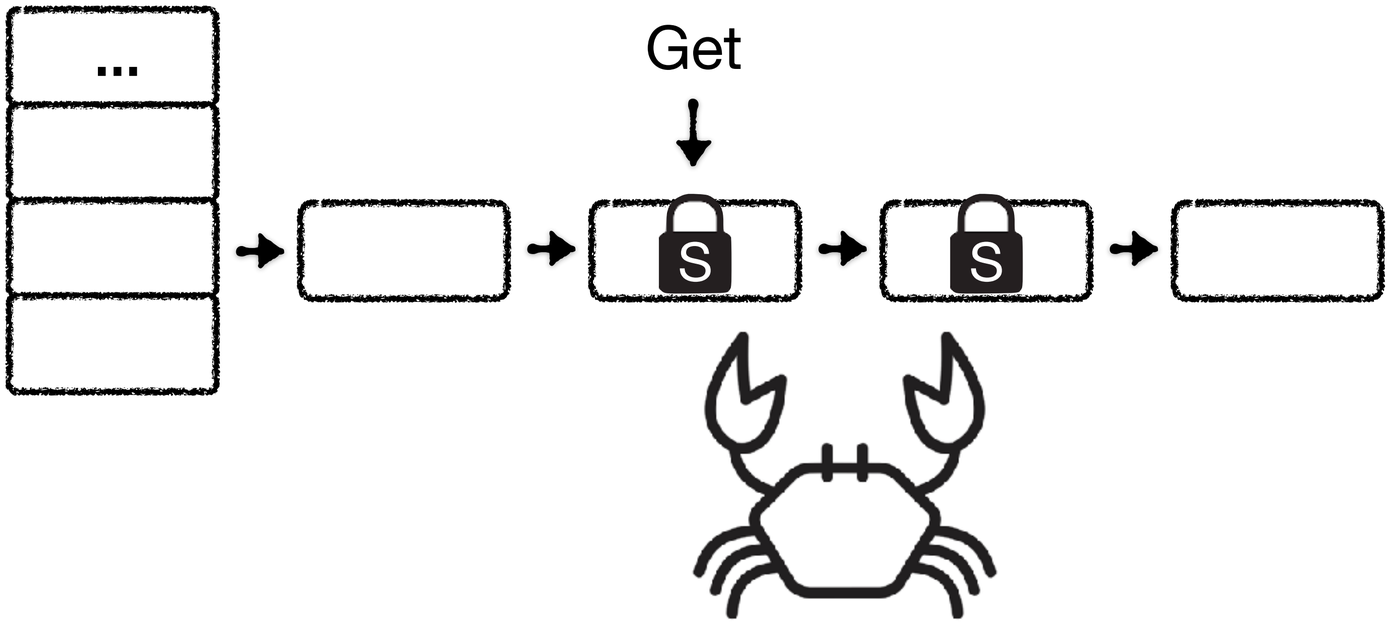

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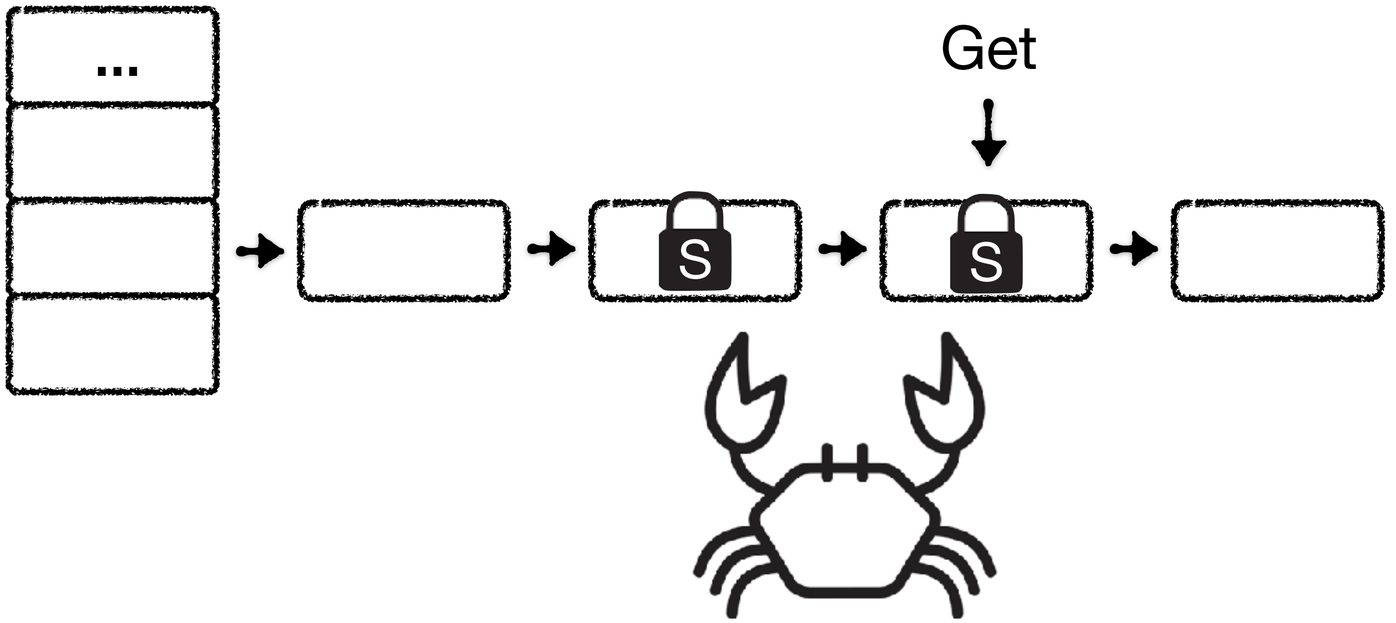

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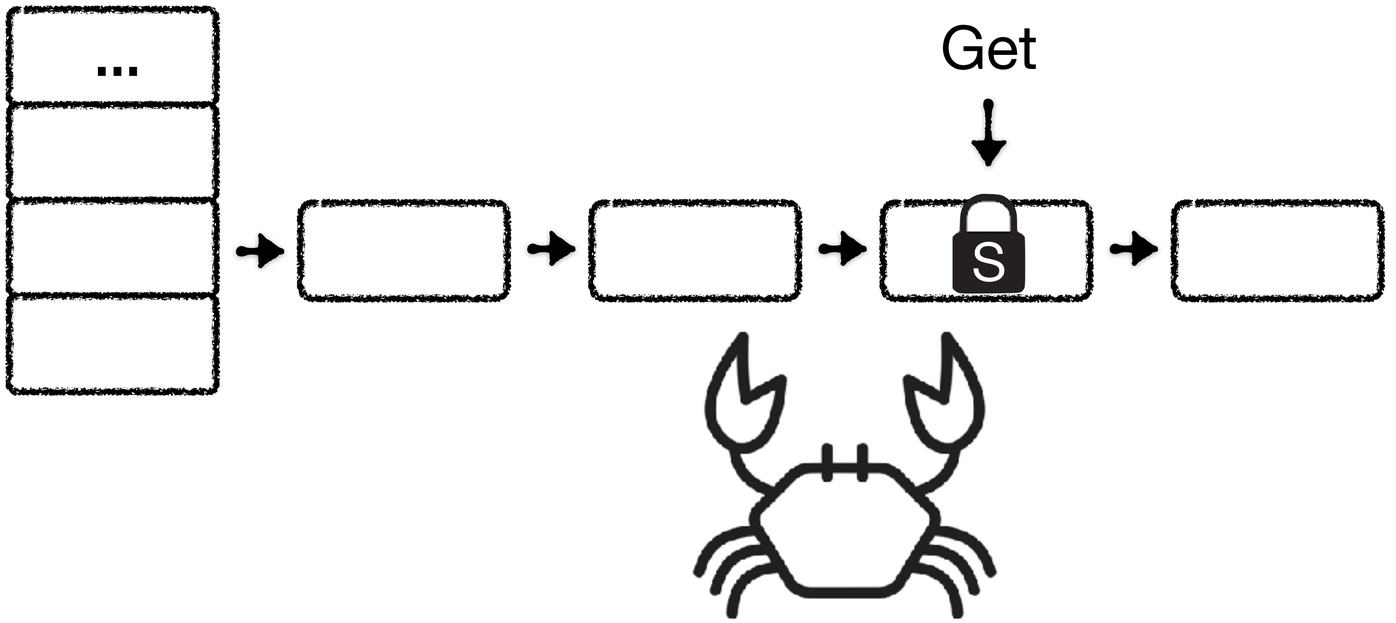

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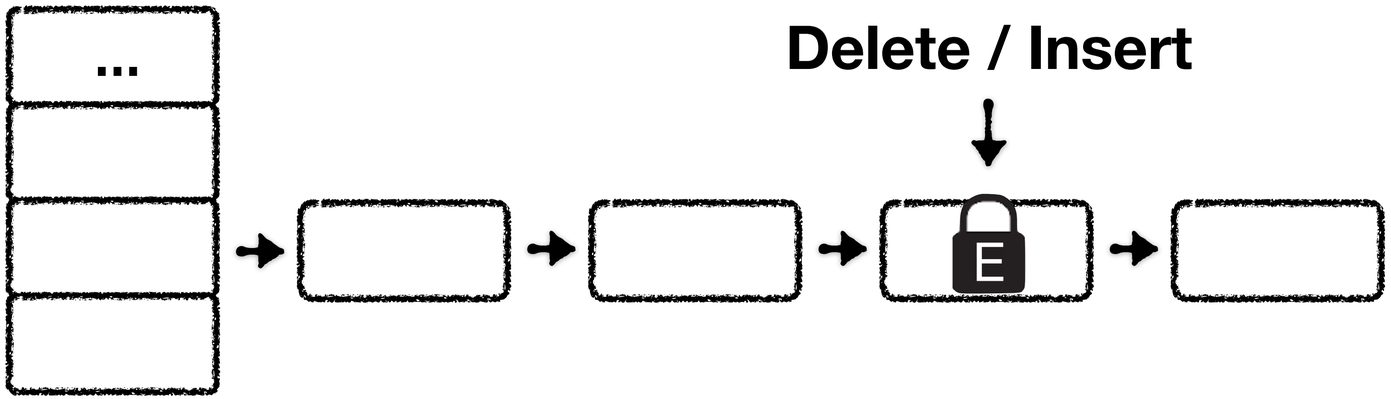
(B) For delete/insert/update, upgrade the lock to exclusive



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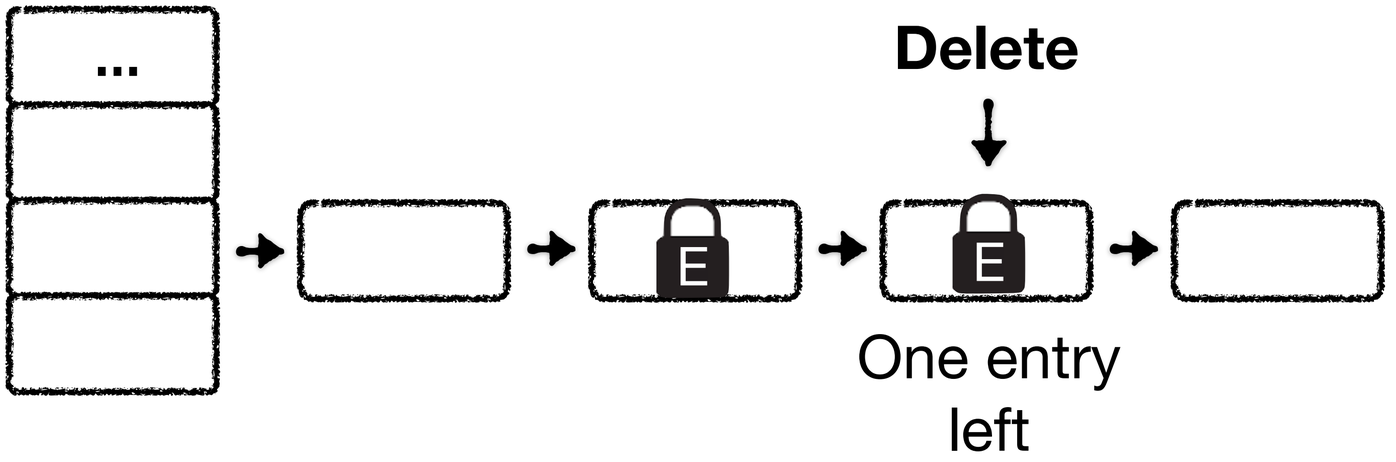

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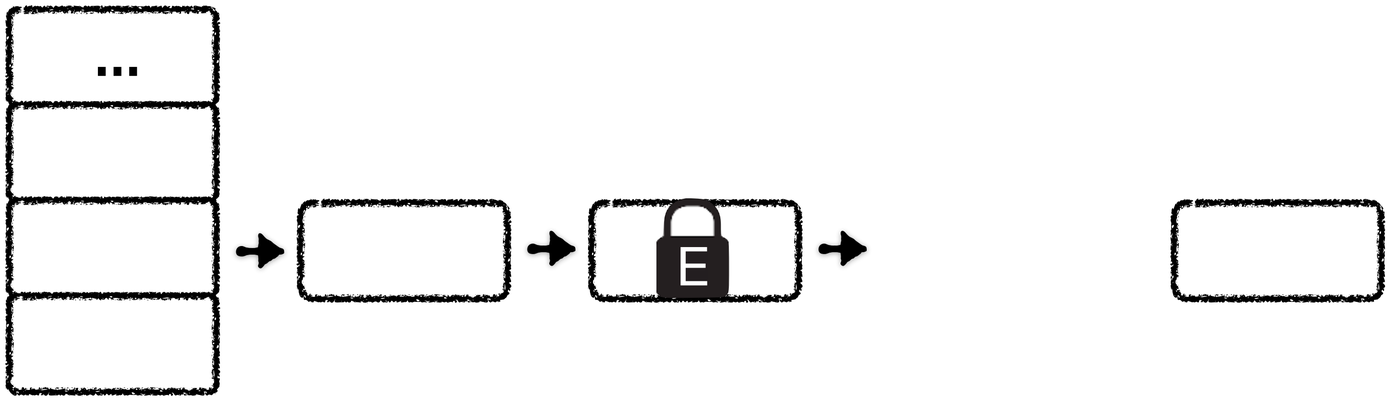

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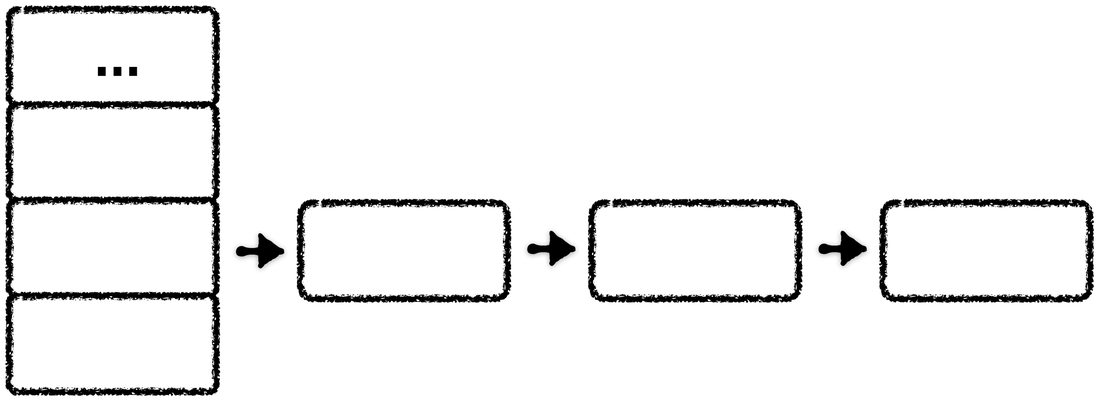

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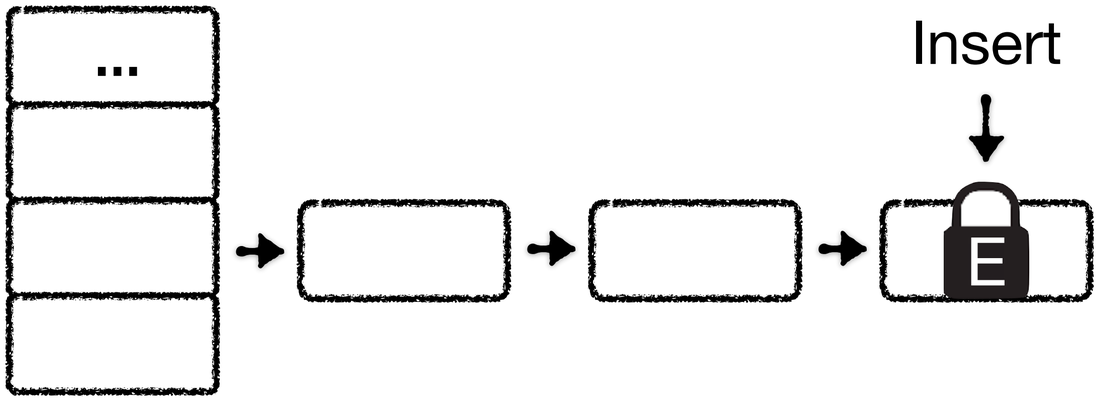

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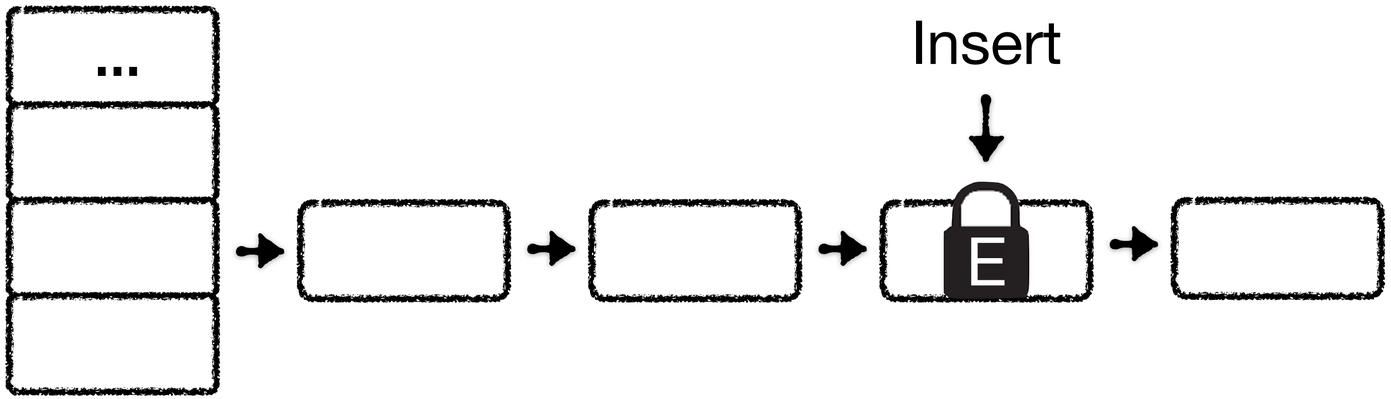

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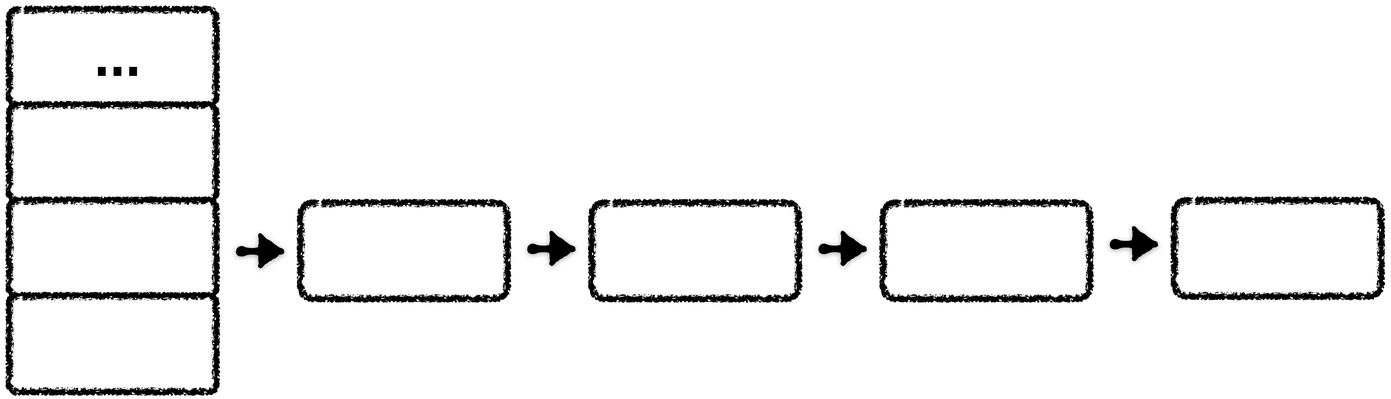
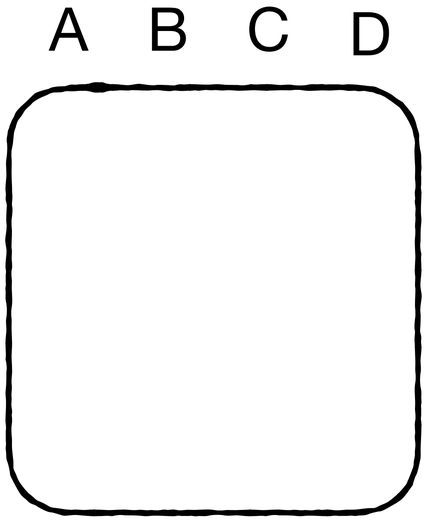


Question 2 - Predicate Locking

The locking mechanism we have seen in class lock physical objects: rows, pages or tables. Instead, it is also possible to lock predicates: “name = “bob” or “salary > 1000”.

(1) How would you implement a predicate lock manager?

(2) Compare the costs qualitatively to a physical lock manager.



Example query:

Select * where (A = “a” and B=“b”) or C=“c” or D > “d”

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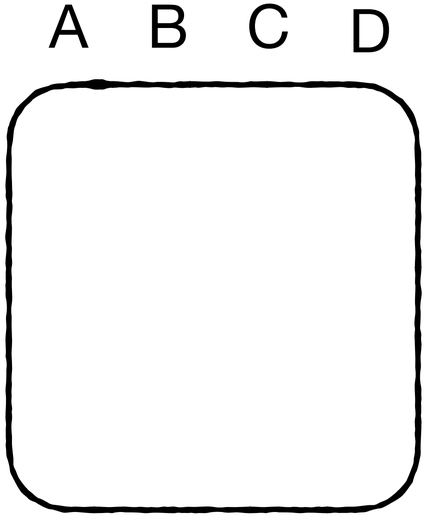

It seems excessive lock predicate individually: **Lock(A=“a”)** **Lock(B=“b”)**

Select * where (**A = “a” and B=“b”**) or C=“c” or D > “d”

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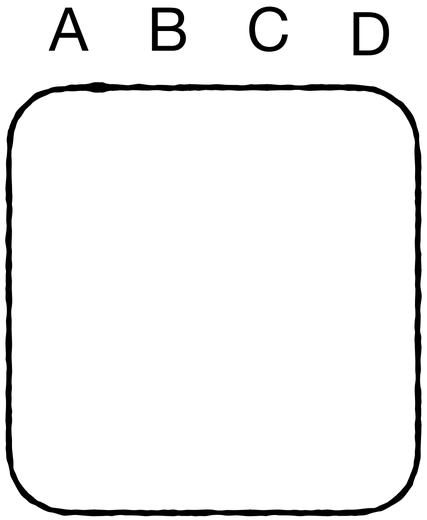
Seems better to lock conjunction: Lock(A="a" and B="b")



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Can lock each conjunctions

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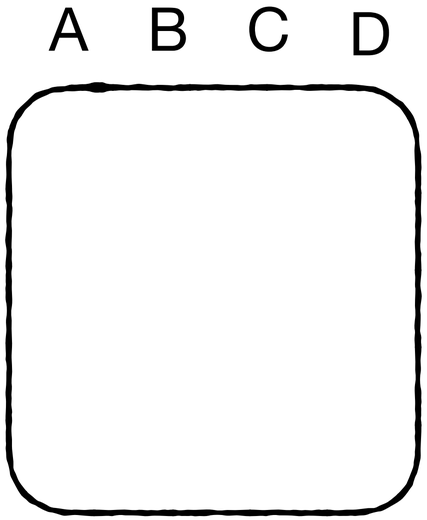
Lock(D > ”d”)



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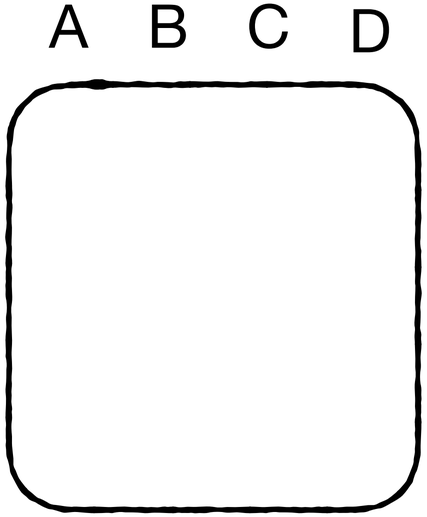

Select * where (A = "a" and B="b") or C="c" or **D > "d"**

Range predicates require a tree for locking different ranges, so each lock is costlier to acquire

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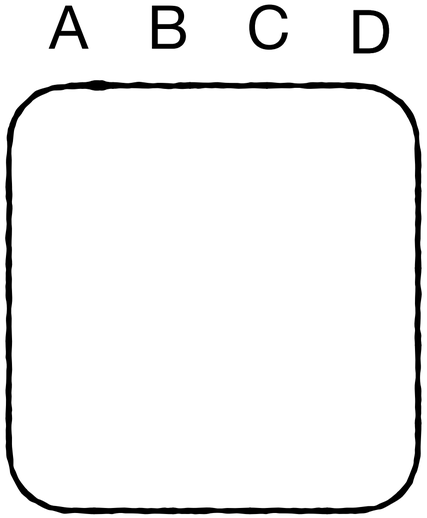

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Consider sorting by column name to prevent having to lock each permutation (e.g., so B = "…" and A ="…" does not need a different lock)

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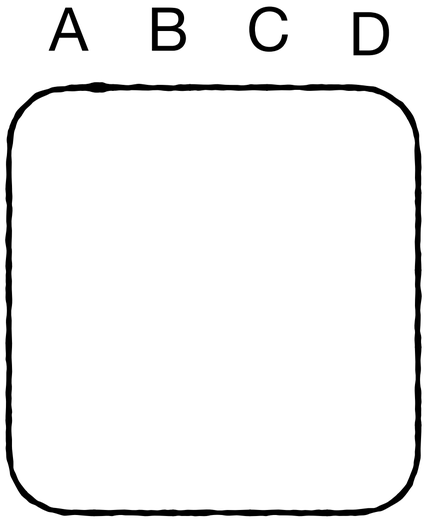

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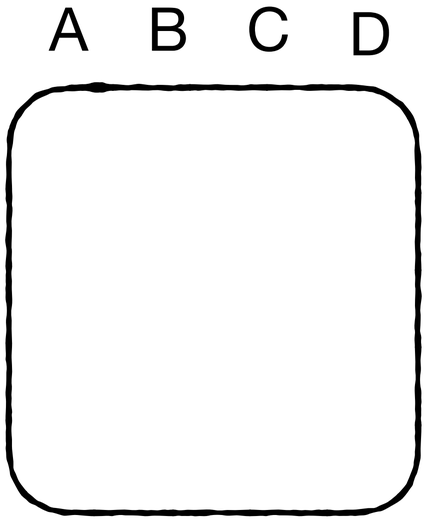

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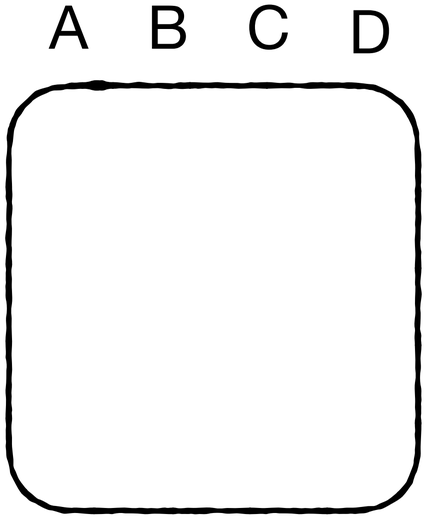

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We could get unrepeatable read and phantoms anomalies

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Pros of predicate locking

for queries returning a lot of objects, locking each predicate rather than object can be cheaper

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Cons of predicate locking

Locking as little as possible while while being able to compare the locking coverage of different queries is highly non-trivial.

E.g., lock as little as possible with ensuring no overlap between these queries

Select * where (A = “a” and B=“b”) or C=“c” or D > ”d”

Update/insert … A = “a” and C=“c”

Question 3 - The Halloween Problem

An update is designed to increase the salary of all employees who earn less than $25000 by 10%. What can go wrong when running this query, and how can we fix it?

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UPDATE employees SET salary = salary * 1.1 WHERE salary < 25000;
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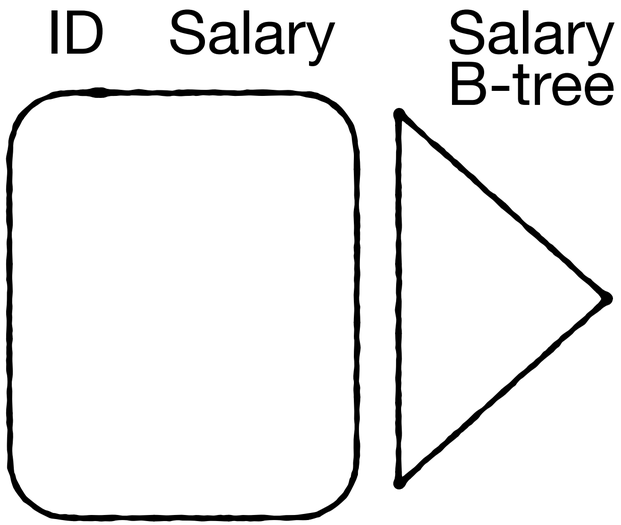

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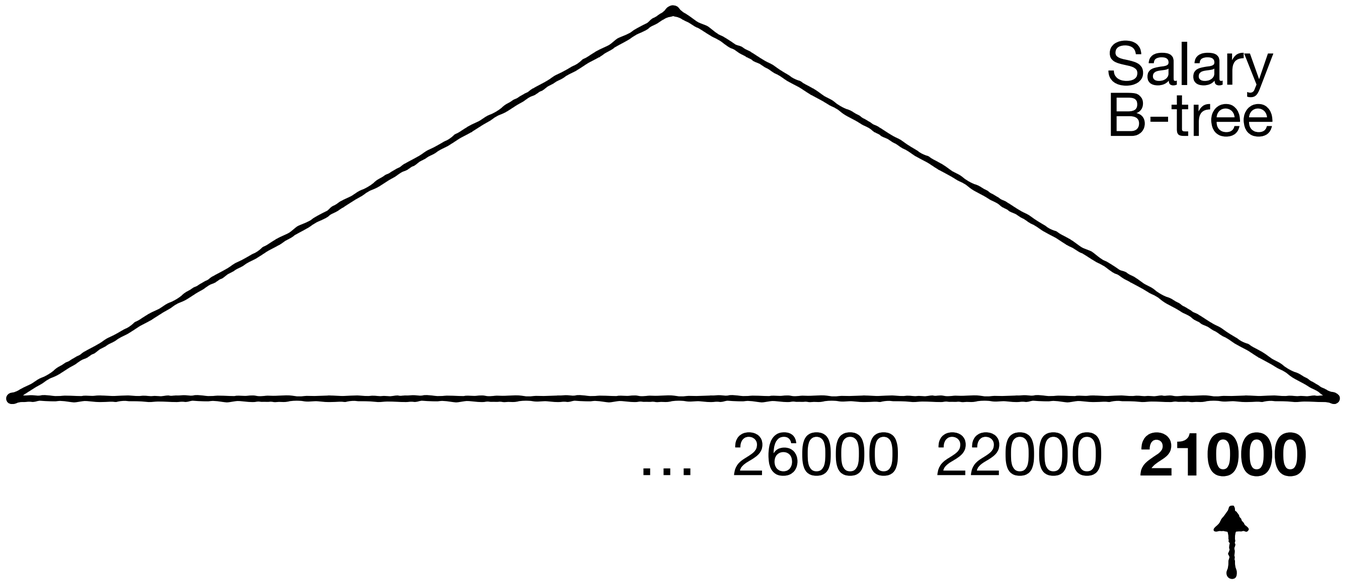

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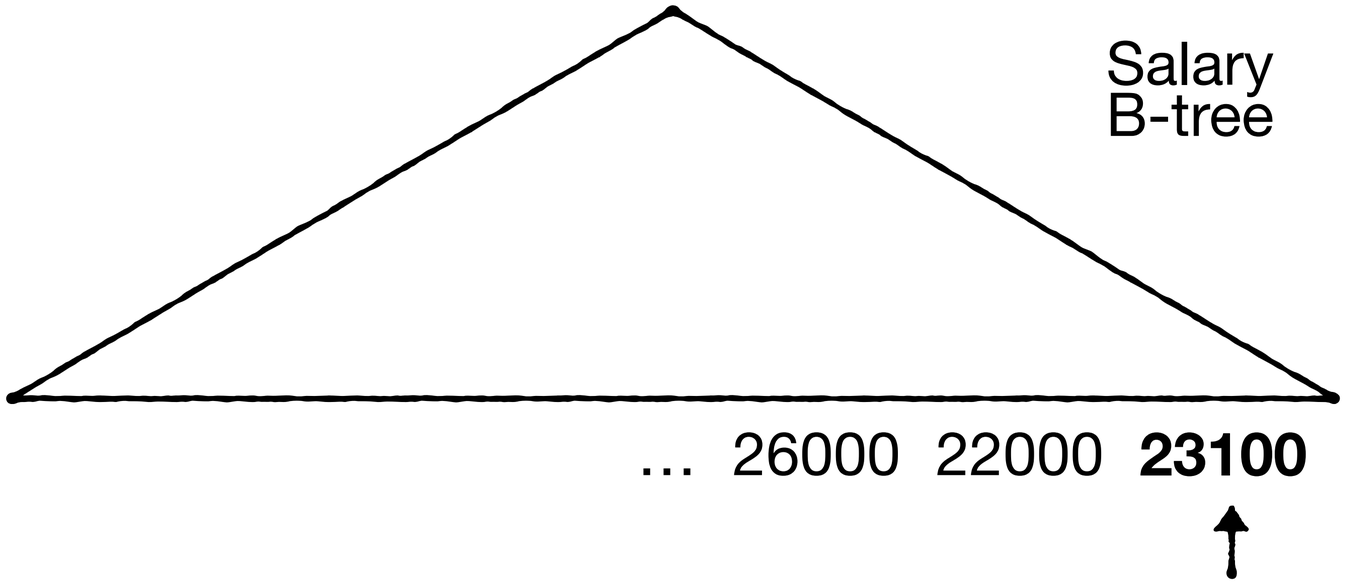

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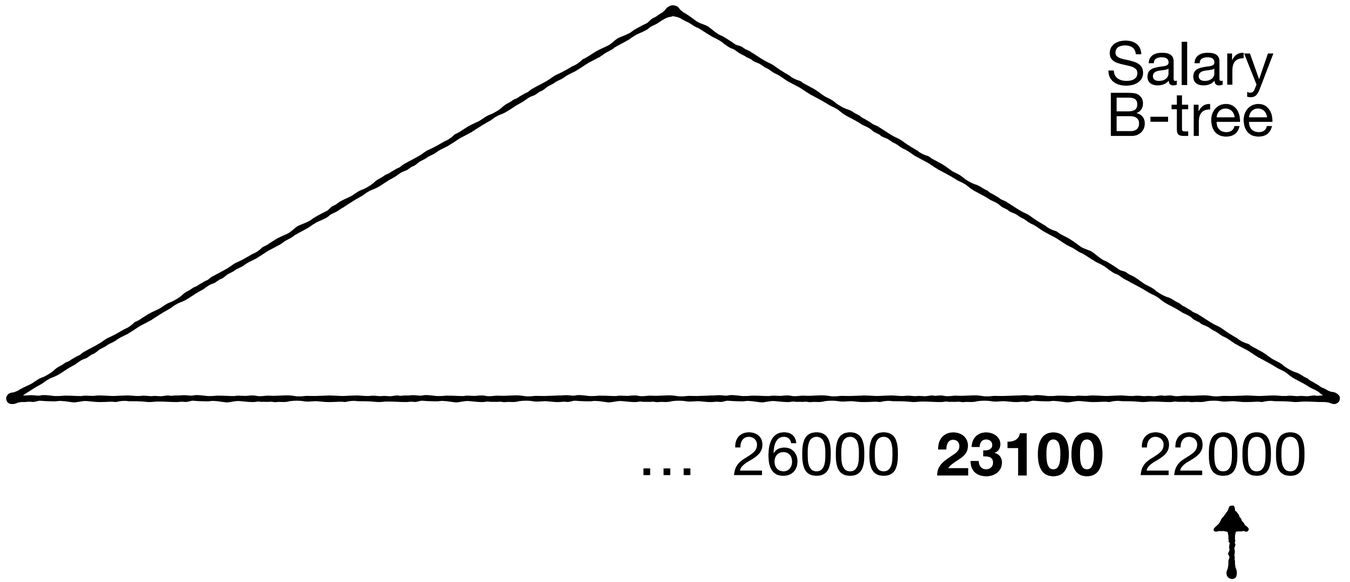

Question 3 - The Halloween Problem

An update is designed to increase the salary of all employees who earn less than $25000 by 10%. What can go wrong when running this query, and how can we fix it?

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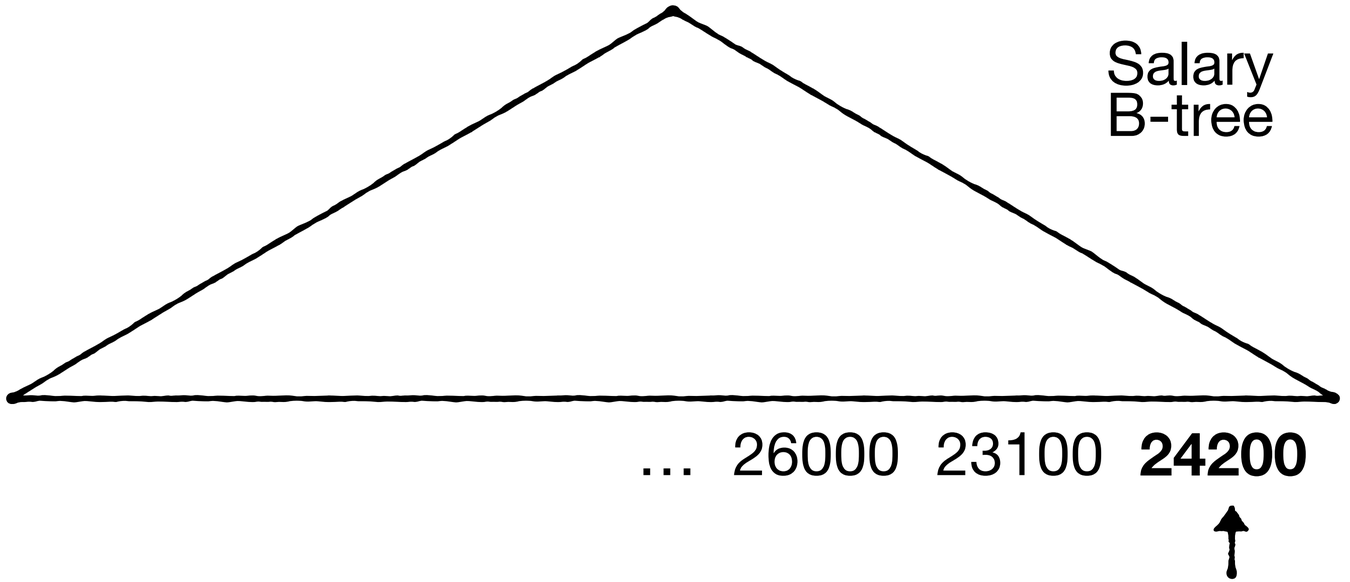

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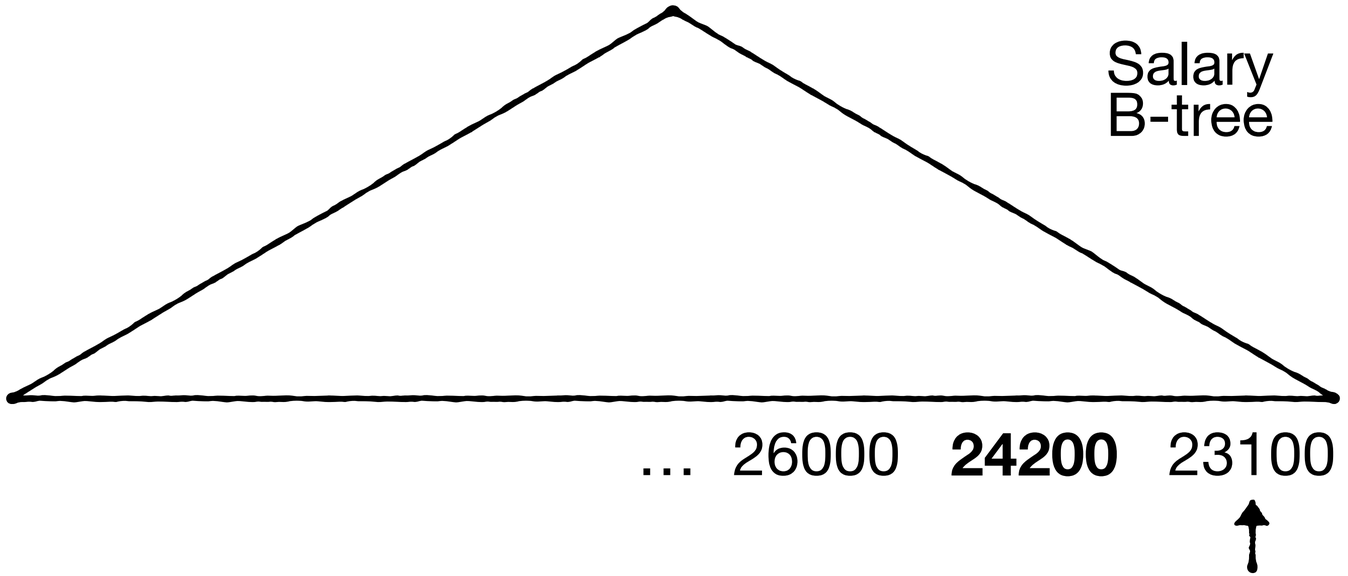

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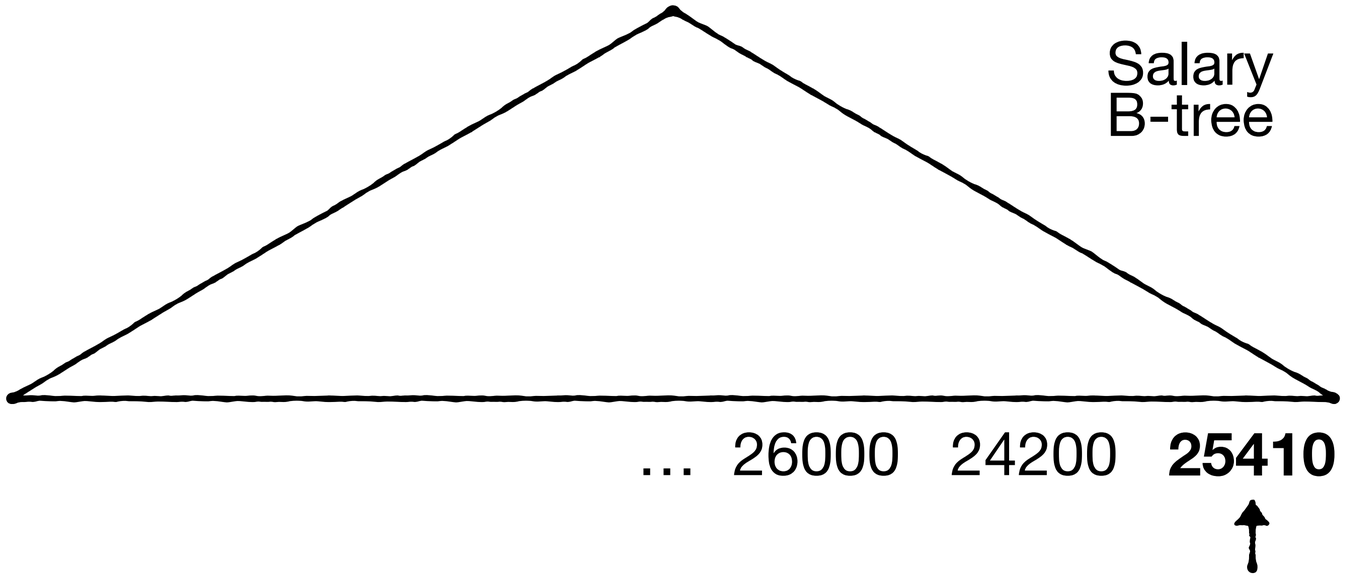

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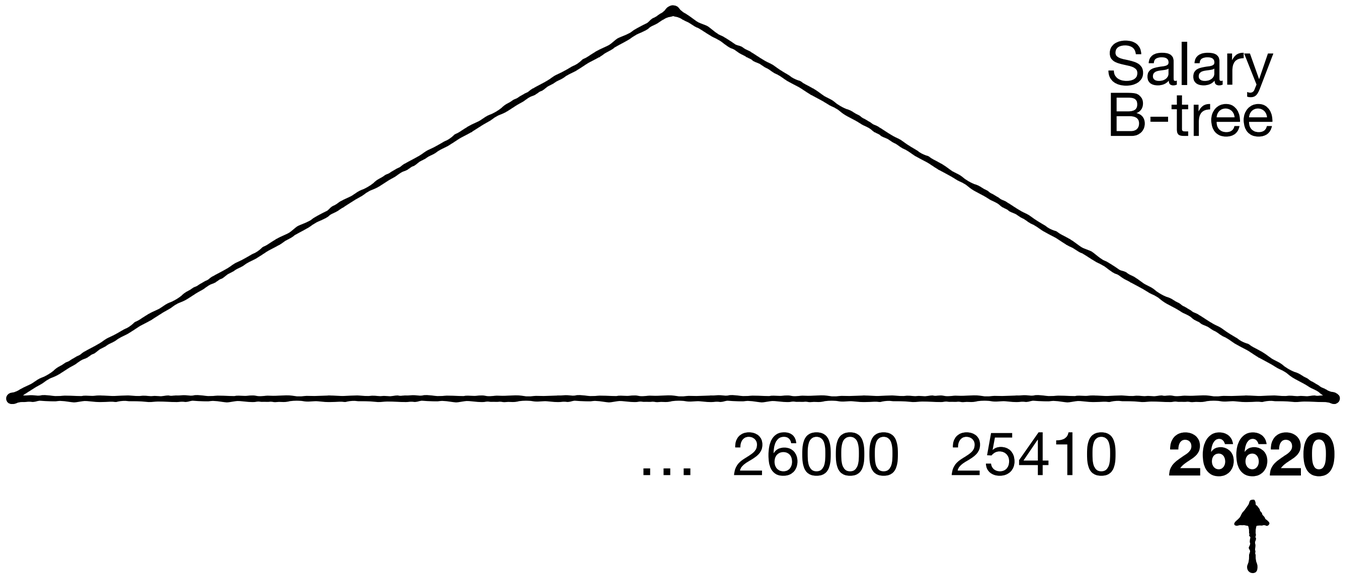

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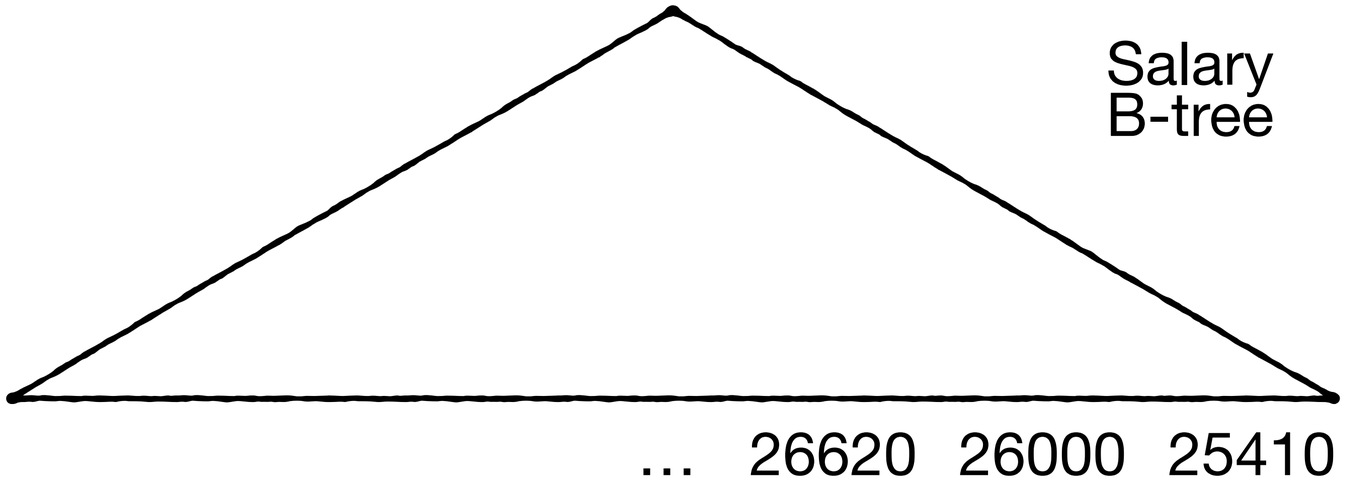

All salaries are now > 25000! This was not the intention :) Consistency is violated.

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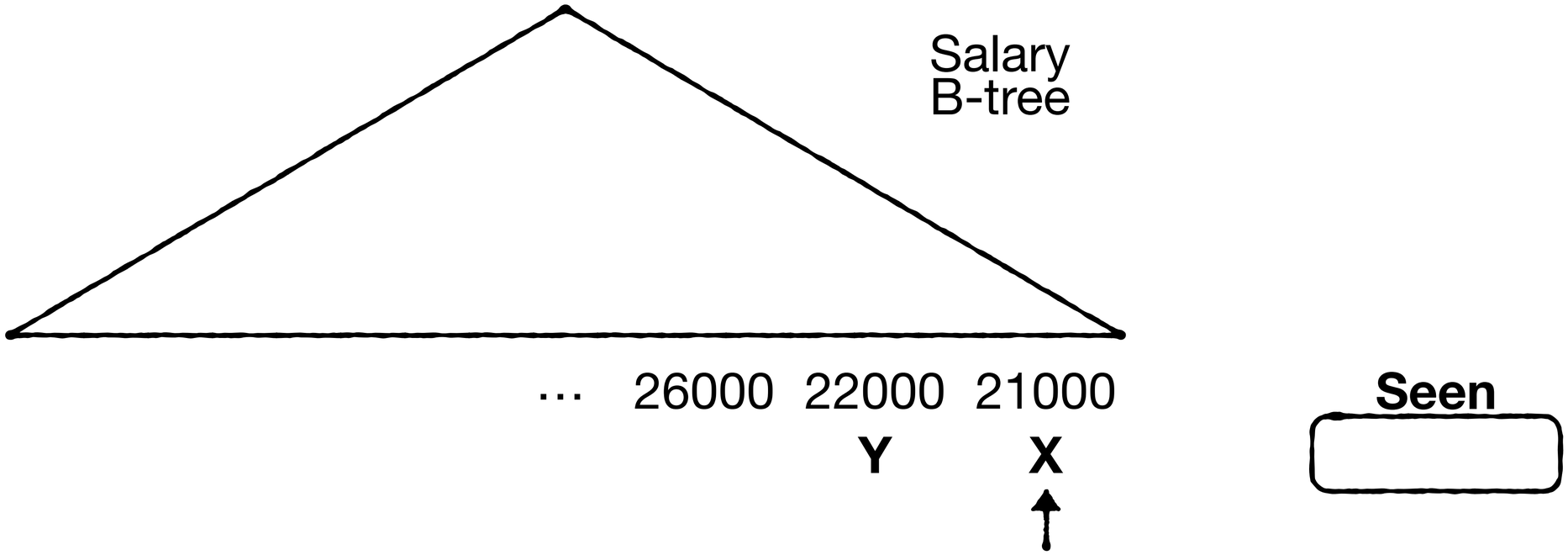

To solve this, keep track of row IDs that had been modified to ensure they are not modified again

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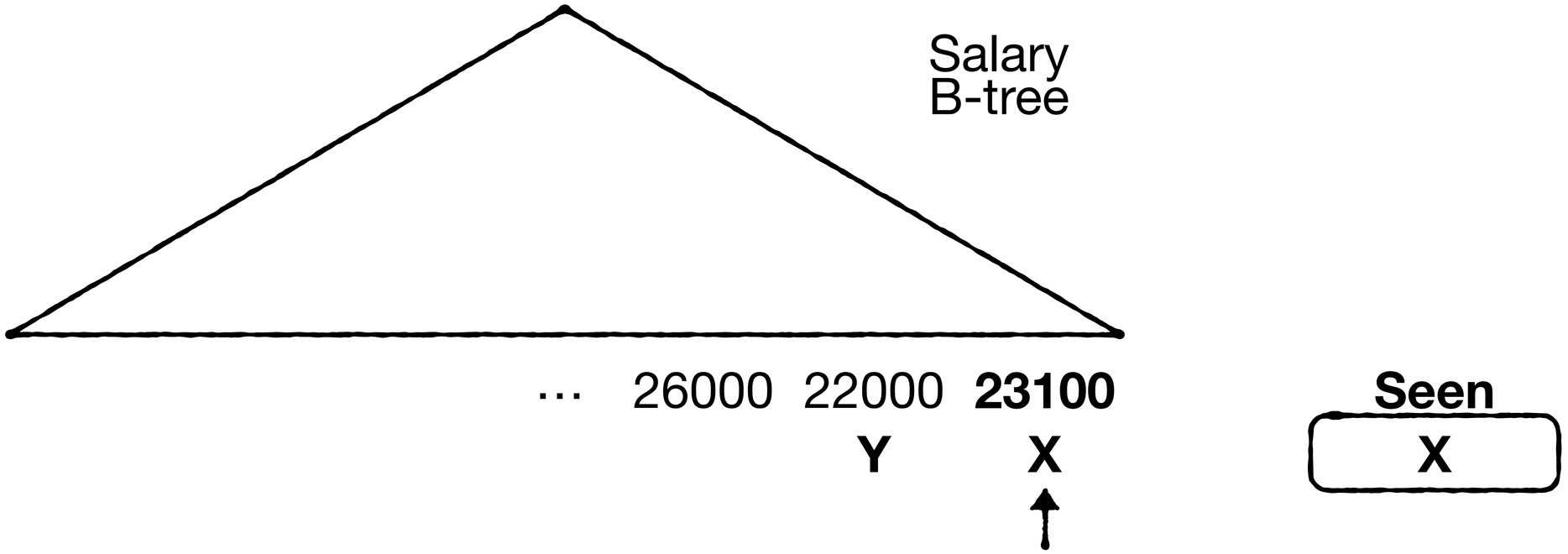

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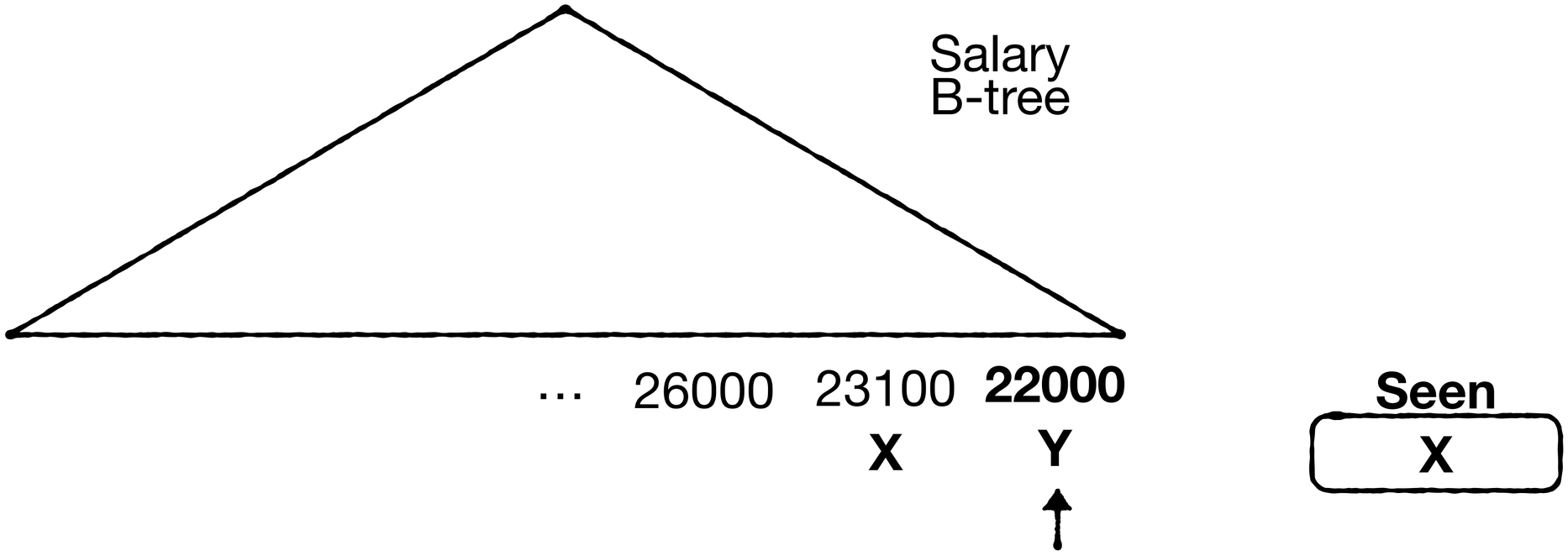

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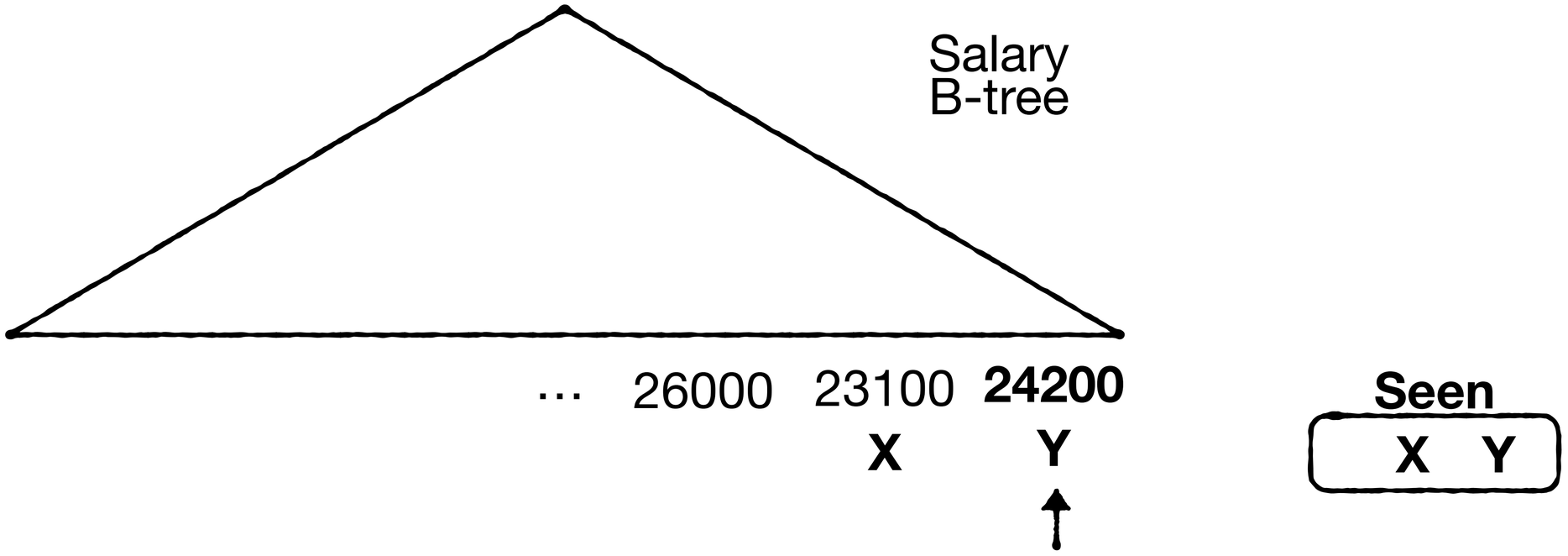

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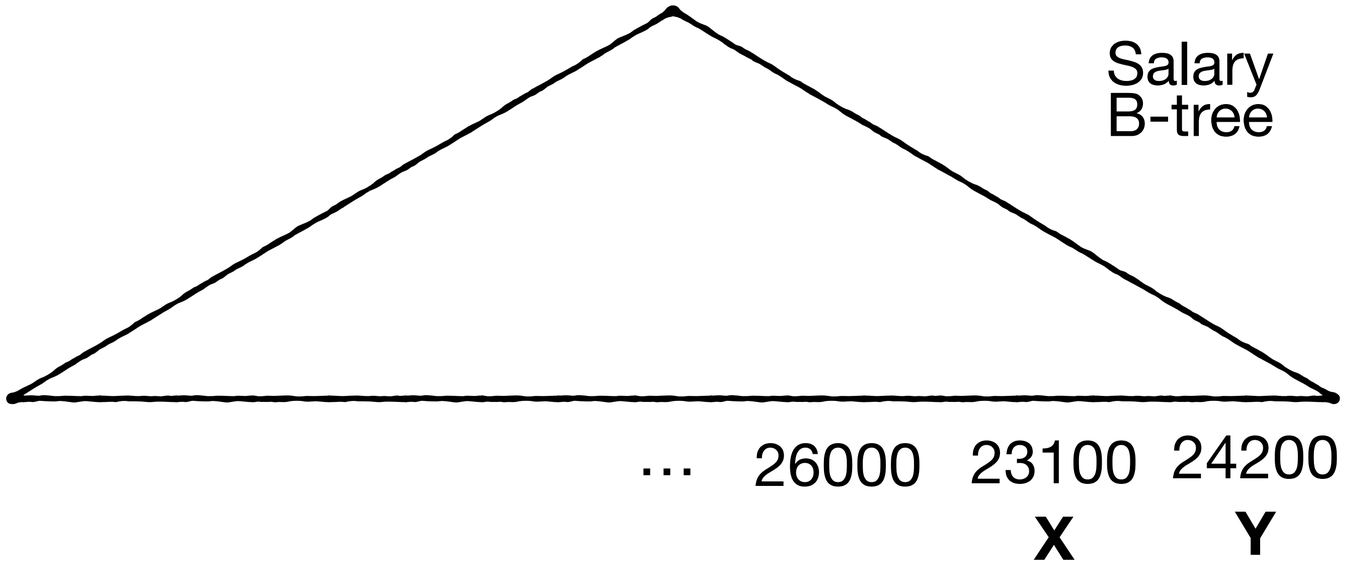

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