INF FAKULTÄT FÜR INFORMATIK

Adaptive Indexing: between Lazy but Lightweight Cracking and Eager but Expensive Merging

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Seminar on Modern Software Engineering and Database Concepts

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Overview of Indexing

Database Indexes:

- help to decrease the query response time;
- sorted column of data with references to the original records;
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- growing amounts of data $\Rightarrow$ larger indexes;
- sophisticated queries $\Rightarrow$ many indexes;
- unpredictable behavior of users $\Rightarrow$ hard to predicate an attribute.

Definition of Adaptive Indexing

Core Idea:

- automated maintenance and tuning of indexes by DBMS;
- continuous reorganization of the physical design during incremental *online indexing*.

Research Goal

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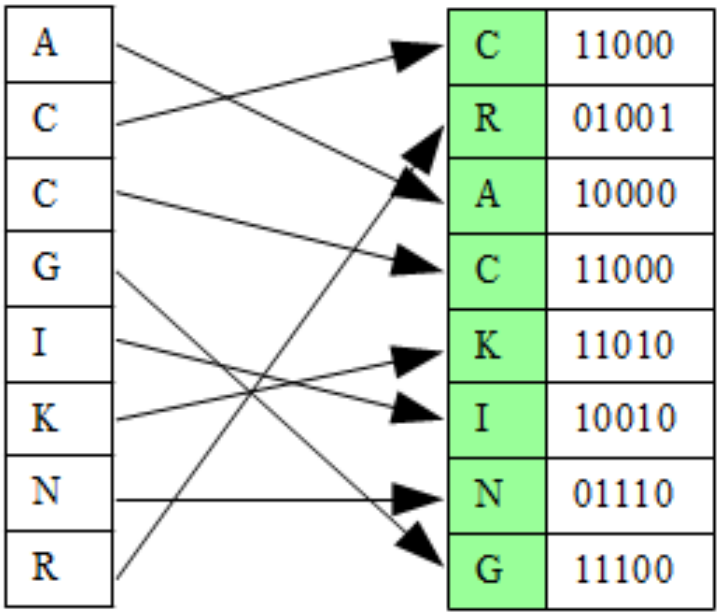
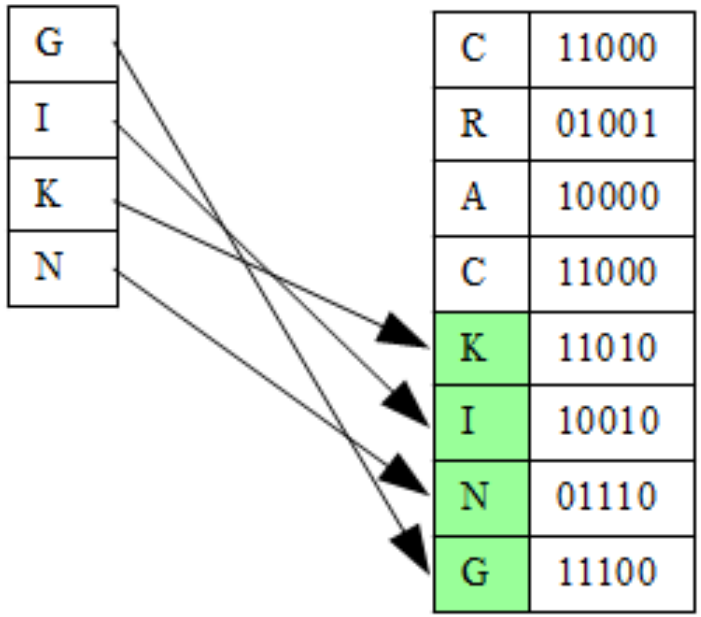
Study the *evolution* of adaptive indexing:

- **Past:** Origin of adaptive indexing.
- **Present:** Current approaches for adaptive indexing.
- **Future:** Unresolved questions regarding adaptive indexing.

Background. Partial Index





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In contrast to *hard indexes*, which are created and managed by DBA, *soft indexes* are created, modified and dropped by a DBMS.

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Workflow:

1. Collect information about the current state of a system.
2. Analyze this information and choose index candidates for materialization.
3. Create or drop some indexes based on this analysis.

Approaches for Adaptive Indexing

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1. Database Cracking:
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2. Adaptive Merging:
   - adaptive nature of cracking;
   - better query response time and quicker adaption.
3. Hybrid Approaches:
   - combine strength of *database cracking* and *adaptive merging*.

Database Cracking

Main Idea: incrementally perform quicksort on a copy of a column using crack-in-three or crack-in-two.

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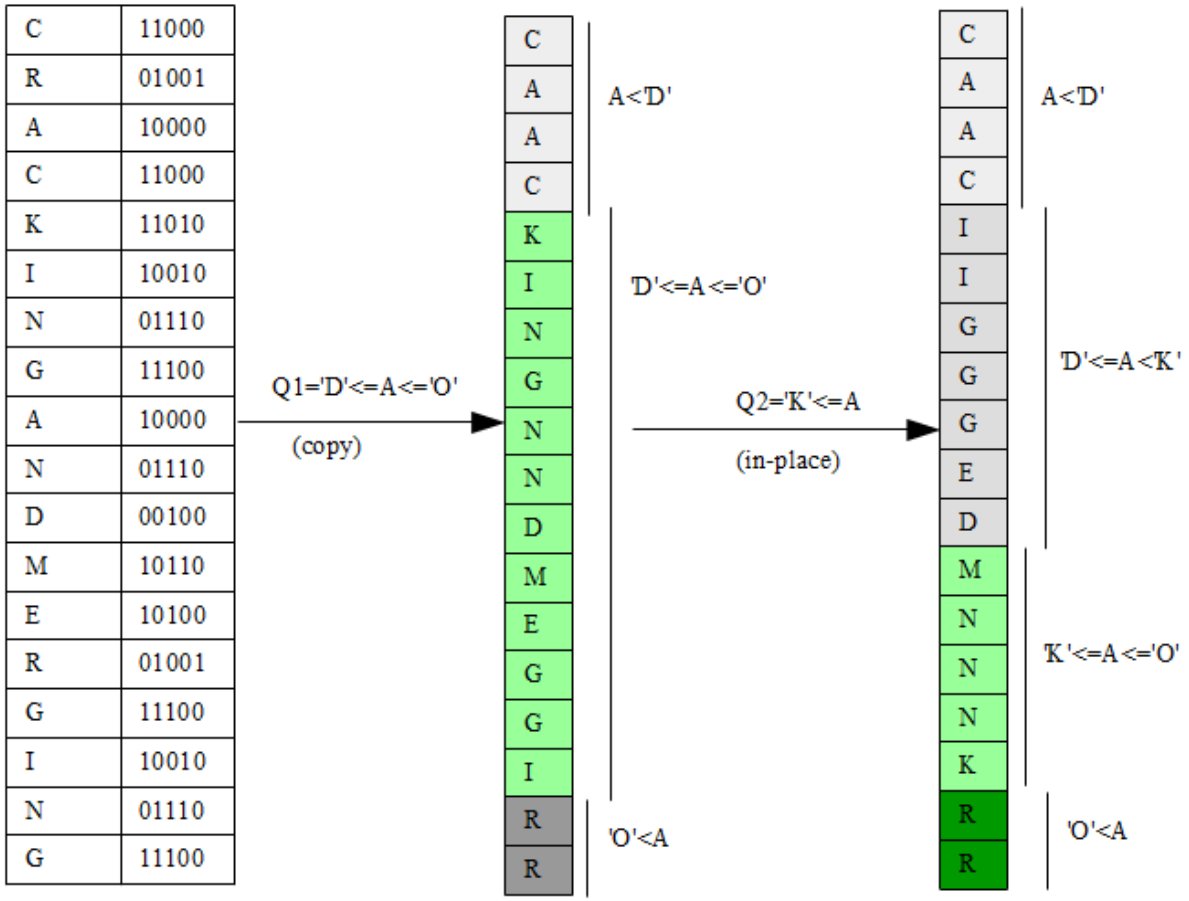

Adaptive Merging

Main Idea: incrementally merge sort the relevant key ranges till a single sorted partition is created.

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C	11000
R	01001
A	10000
C	11000
K	11010
I	10010
N	01110
G	11100
A	10000
N	01110
D	00100
M	10110
E	10100
R	01001
G	11100
I	10010
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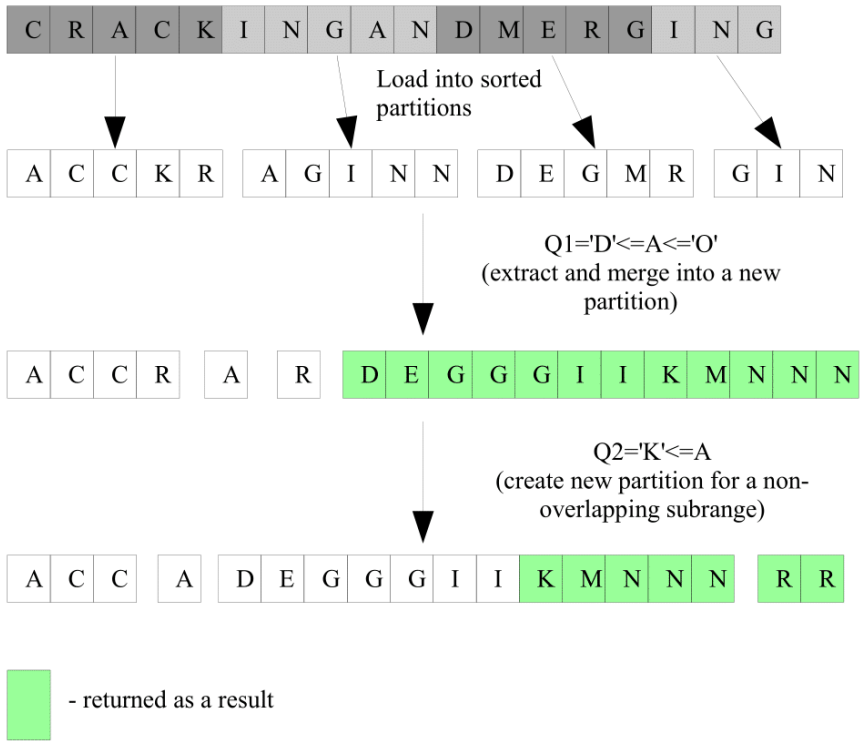

Database Cracking vs. Adaptive Merging

Initial Run
Response Time
Convergence

Database Cracking vs. Adaptive Merging

	Database Cracking
Initial Run	slightly slower than scan
Response Time	faster than scan after 1^{st} query
Convergence	after 1k queries, 40% slower than full index

Database Cracking vs. Adaptive Merging

	Database Cracking	Adaptive Merging
Initial Run	slightly slower than scan	approx. 5 times slower than scan
Response Time	faster than scan after 1^{st} query	first queries are slower than scan
Convergence	after 1k queries, 40% slower than full index	10M records $\Rightarrow$ approx. 40 queries

Hybrid Approaches

Strategy

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1. Find the general structure:
   - load data into partitions;
   - extract relevant data from each partition (*crack*);
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   - Crack;
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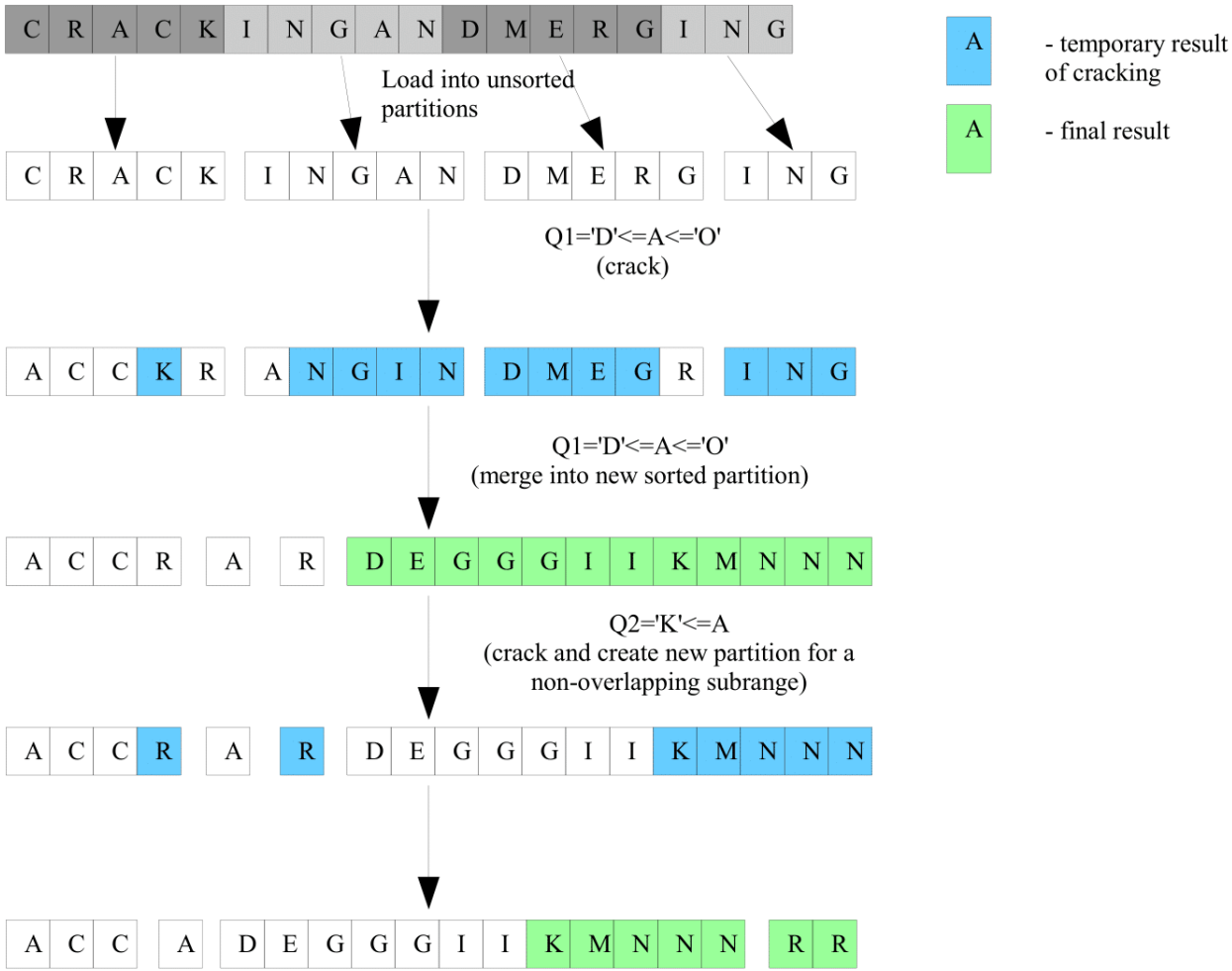
Hybrid Approaches

Strategy

1. Find the general structure:
   - load data into partitions;
   - extract relevant data from each partition (*crack*);
   - load data into final partitions.
2. How to make components *strong*?
   - Crack;
   - Sort;
   - Radix.
3. Combine *strong* components
   - Sort-*;
   - Crack-*;
   - Radix-*.

Crack-Sort Algorithm



Lessons Learned

- Adaptive Indexing Is a Promising Concept;
- Database Cracking and Adaptive Merging Have Similar Nature;
- Crack-Sort and Crack-Radix Are Valid Alternatives;
- Hybrid Algorithms Can Be Combined.

Future Work

- Further Research on Adaptive Merging and Hybrid Approaches Needed;
- New Strategies for Hybrid Algorithms;
- Influence of Undelying Data Structure;
- Integration of Adaptive Indexing into Other Models;
- Extensions to the Methods.

Thank you for your attention!

Questions? Recommendations? Remarks?

Literature

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