Designing an Index for ZooDB

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Outline

1 Introduction

2 Goals & Challenges

3 The new Index Implementation

4 Benchmarks

ZooDB

- an open source object database written in Java
- JDO standard compliant
- 4 times faster than competitor db4o
- `zoodb.org`

Database Index

Key-Value data structure for fast retrieval and ordered iteration of entries stored in a file.

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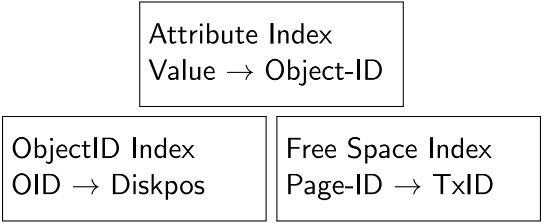

Attribute Index
Value → Object-ID

ObjectID Index
OID → Diskpos

Free Space Index
Page-ID → TxID

B+ Tree

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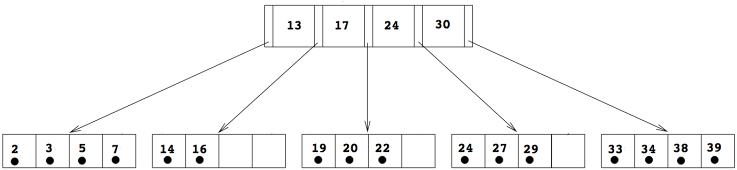

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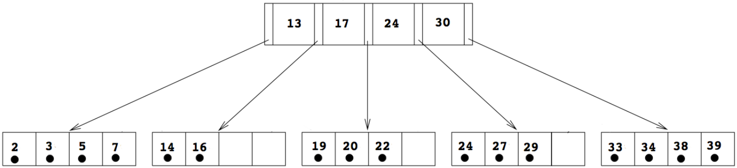

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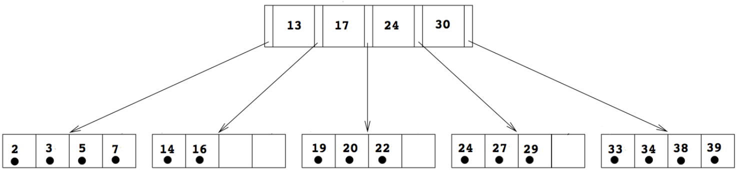

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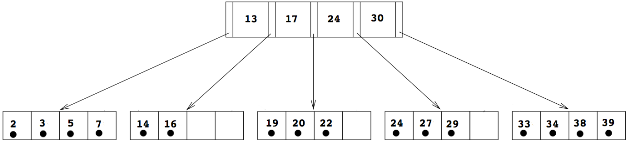

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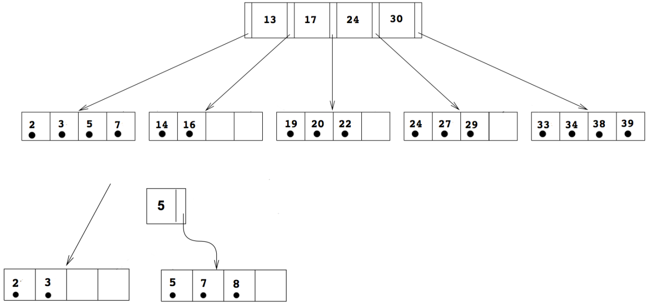

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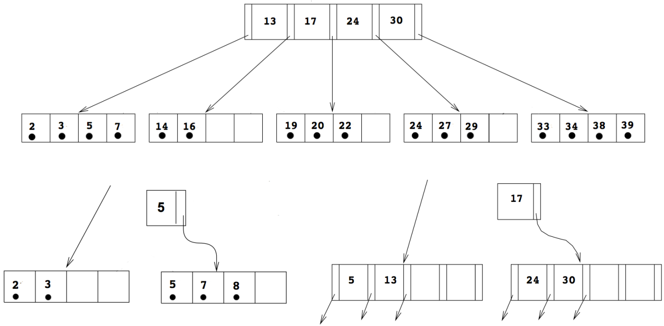

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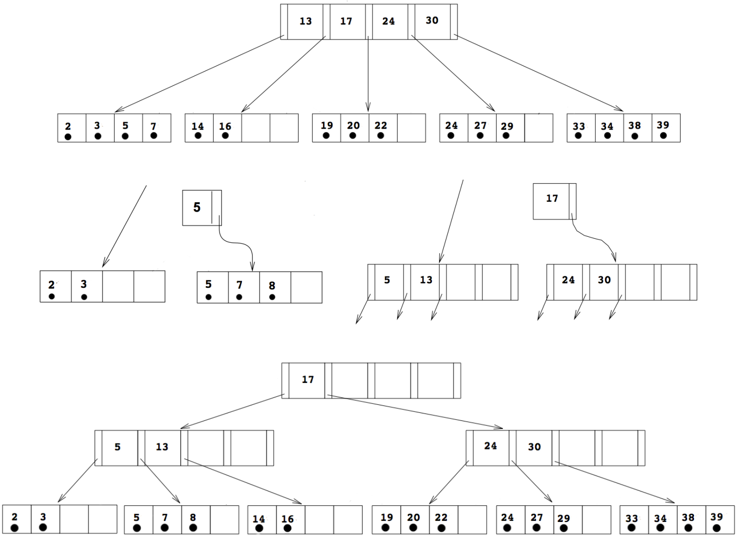

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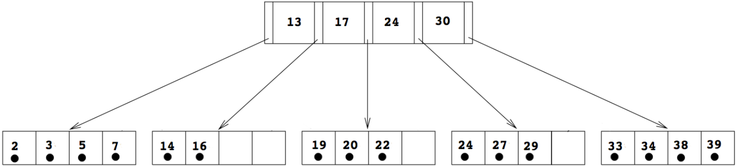

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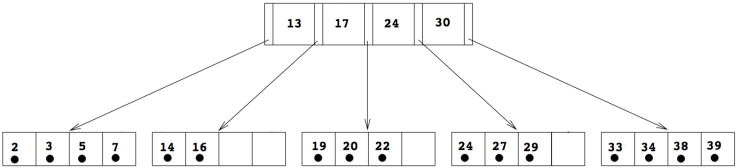

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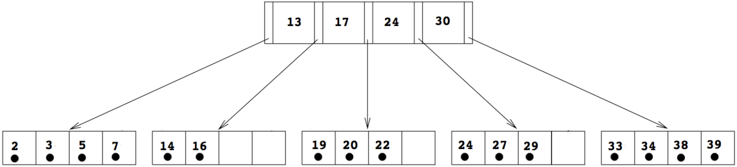

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- Insert, remove, search are logarithmic.

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Exploit common prefix

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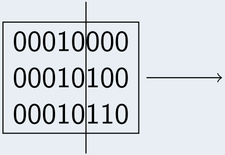

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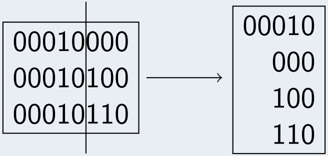

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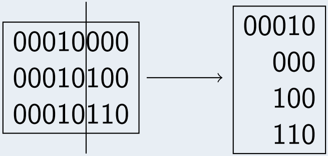

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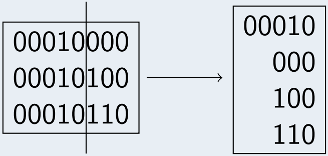

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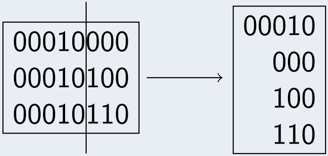
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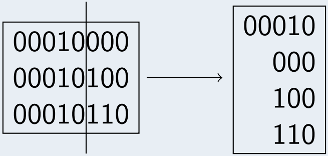

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- variable number of key-value entries per node
- prefix determines
    - if two nodes can be split without underflow
    - if two nodes can be merged without overflow
    - the number of entries that can be redistributed from one node to the other

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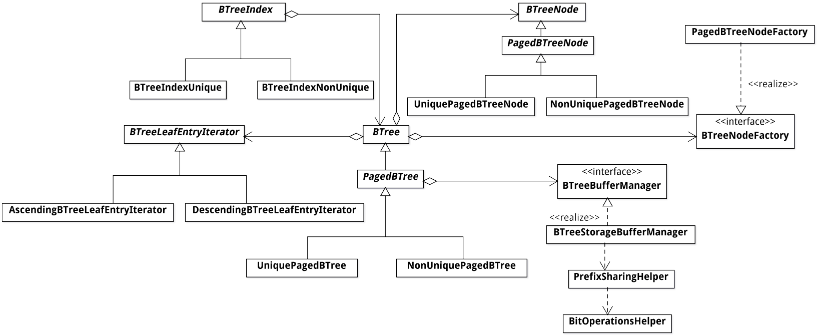
  1. not optimized for practical scenarios
  2. do not cover duplicates nor prefix sharing
- low-level implementation optimizations

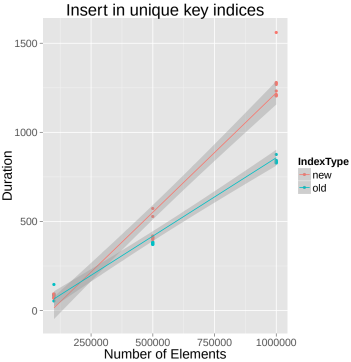
Index Implementation



Operations

- Search - Similar to normal B+ Tree
- Insert overflow
    - attempt to redistribute values to left sibling before creating a new node
- Delete underflow
    - check if possible to merge with left or right neighbour
    - check if possible to split current node between left and right
    - redistribute from left or right
- Write
    - only write dirty nodes
    - prefix encoding

Microbenchmarks



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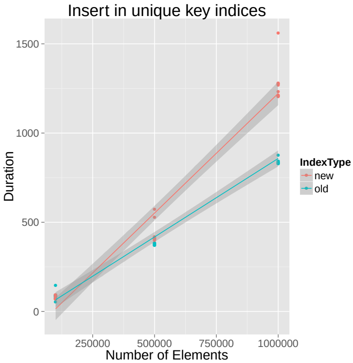

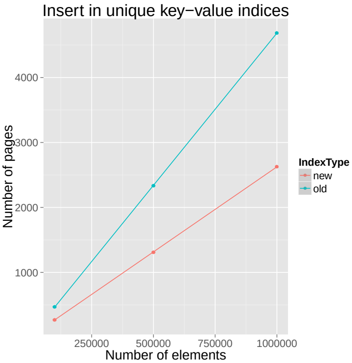

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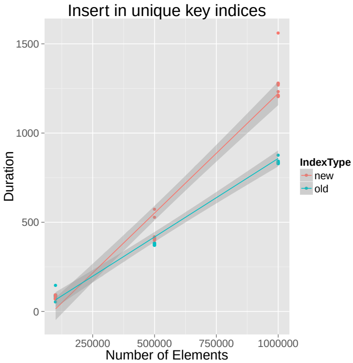
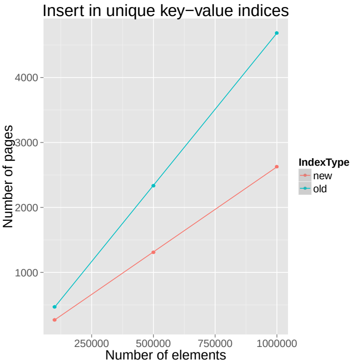

Insert in unique key indices


Insert in unique key−value indices

- in every microbenchmark the new index is significantly slower
- in most microbenchmarks there s a significantly lower number of nodes

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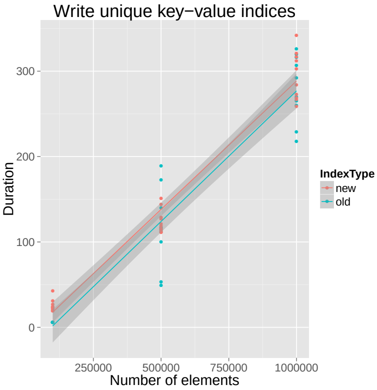

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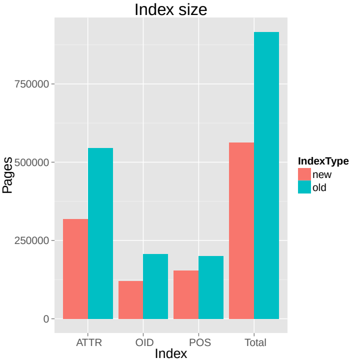

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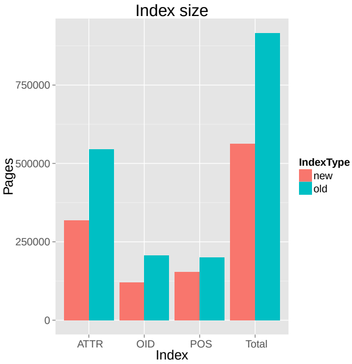

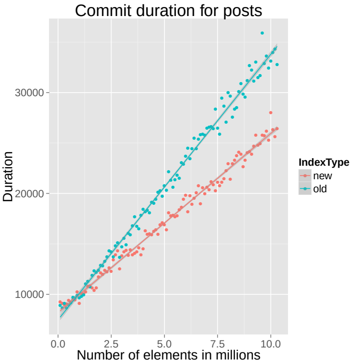

Summary

- ...

Outlook

- ...