Designing an Index for ZooDB

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Outline

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 that allows for fast retrieval and ordered iteration of records stored in a file.

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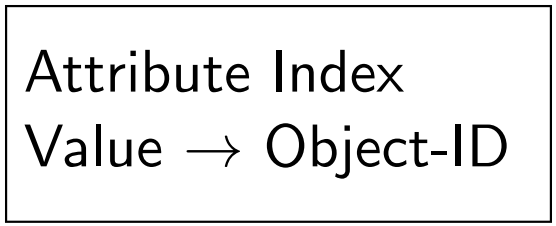

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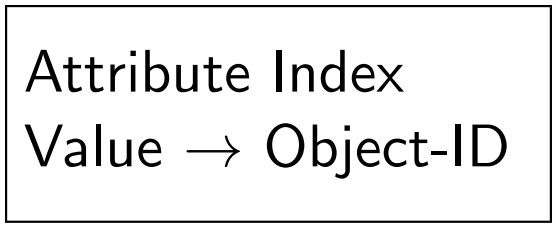
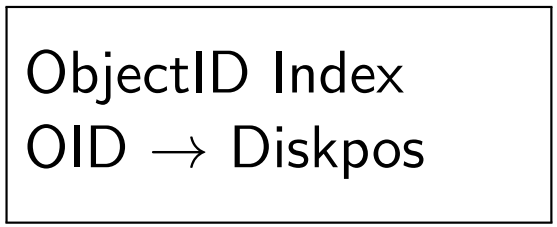
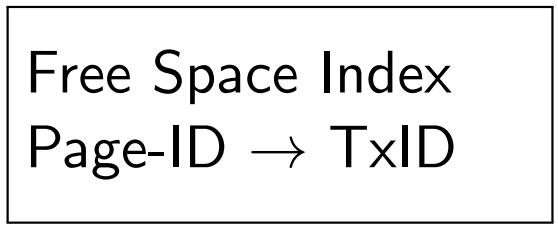
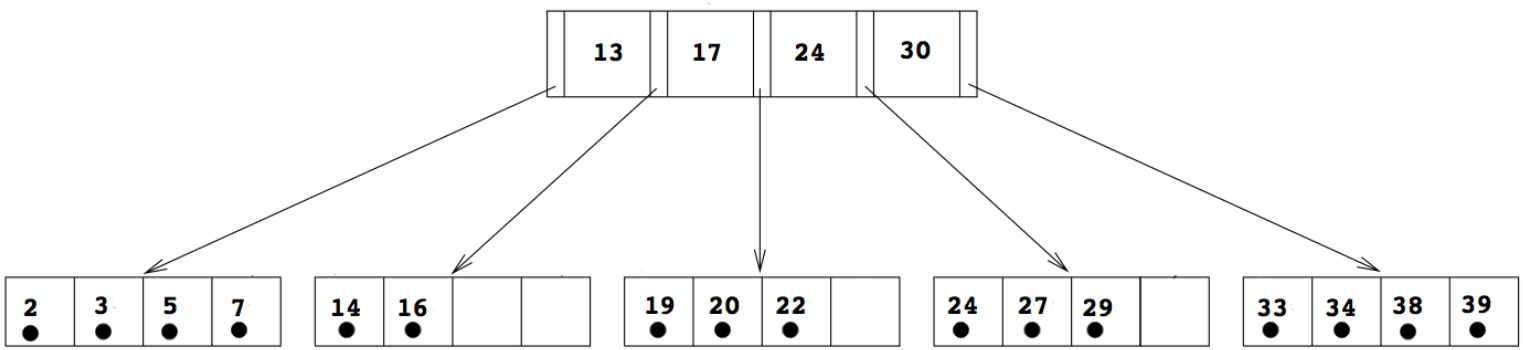




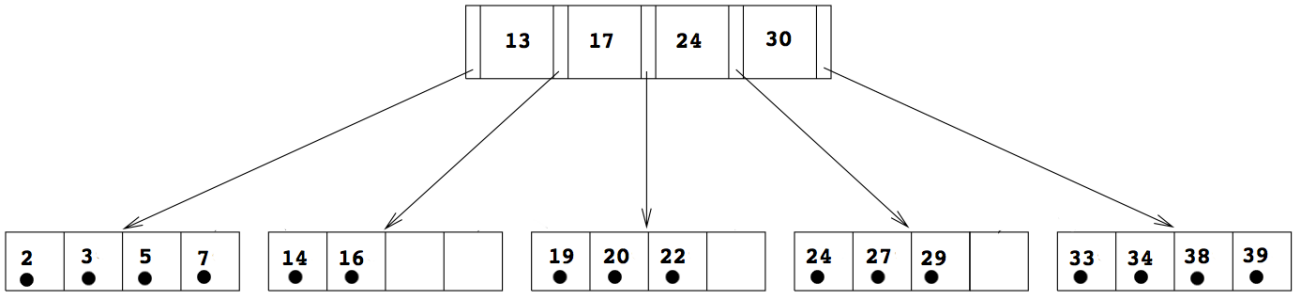


B+ Tree



- node fills one disk page
- inner node contains keys and children pointer, leaves contain keys and values
- key unique vs. key-value unique

Example: insert $(8, v)$



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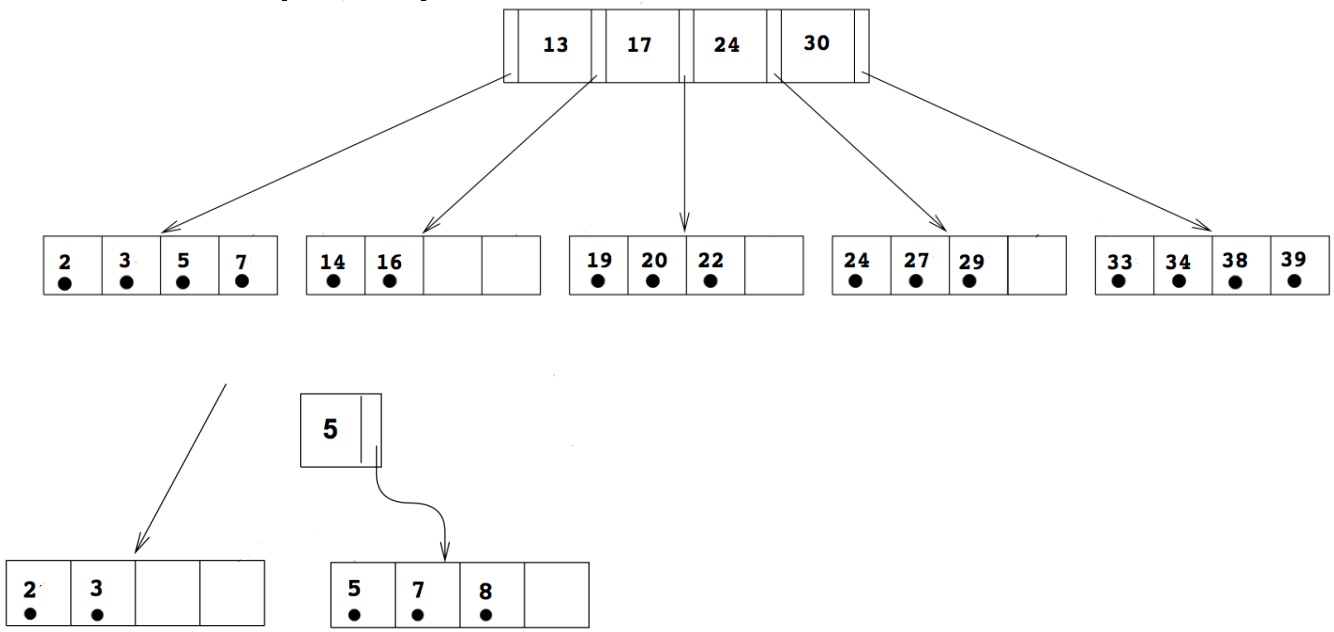

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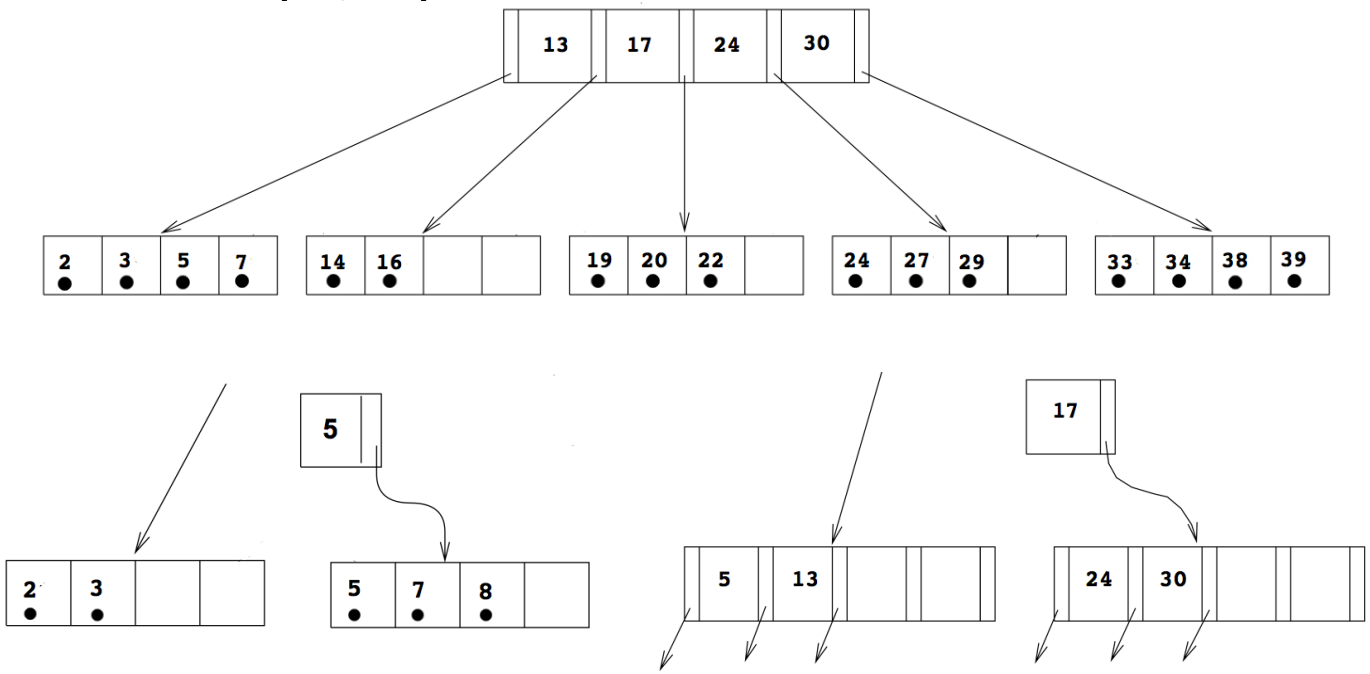

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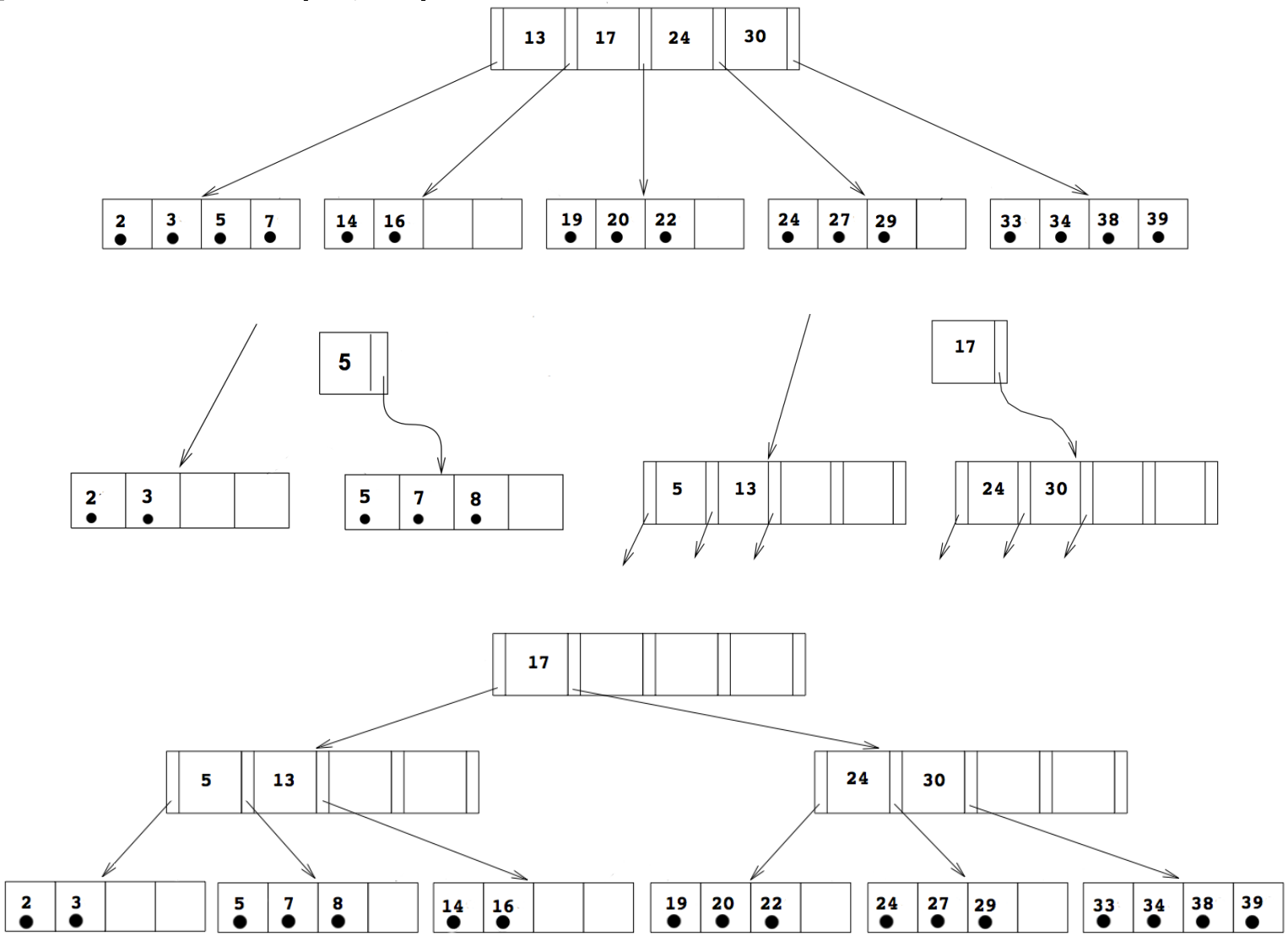

Goals

- fast B+ tree index
- key unique and key-value unique
- buffer manager to allow caching
- prefix sharing

Prefix Sharing

Exploit common prefix

00010000
00010100
00010110

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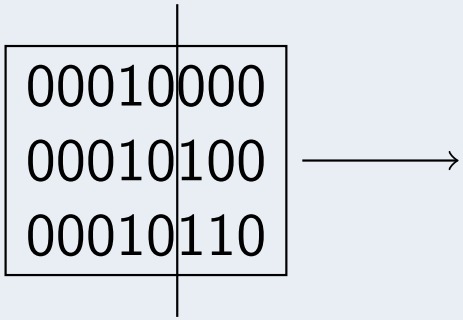
Exploit common prefix



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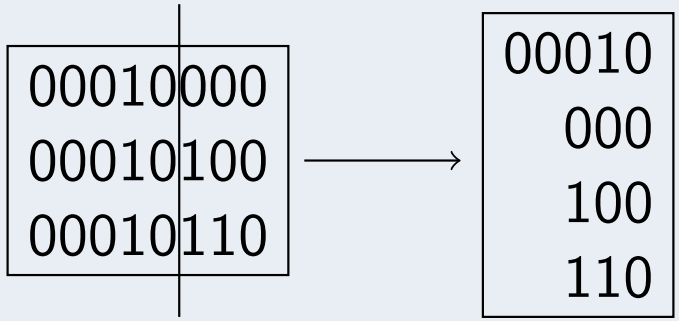

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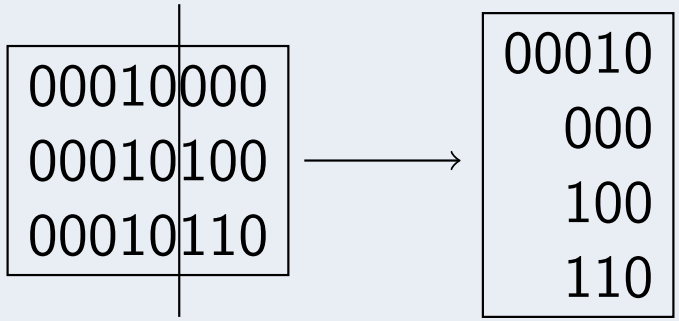
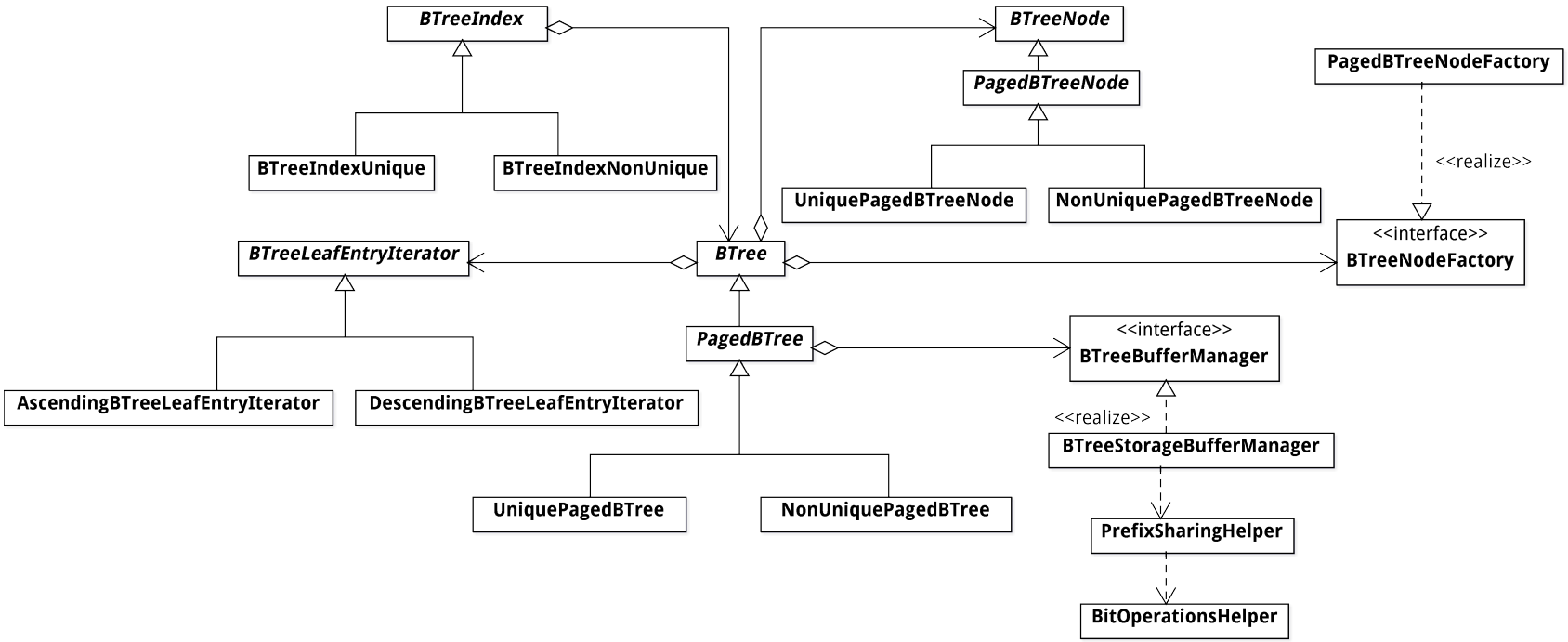


- variable number of key-value entries per page
- prefix determines
  - if 2 nodes can be merged without overflow
  - the number of entries that can be redistributed from one node to the other

Challenges

- runtime dominated by disk access
  - prefer few nodes
  - rarely modify nodes
- new features are costly
- Textbook algorithms need to be adapted
  1. not optimized for practical scenarios
  2. do not cover duplicates nor prefix sharing
- Low-level implementation optimizations

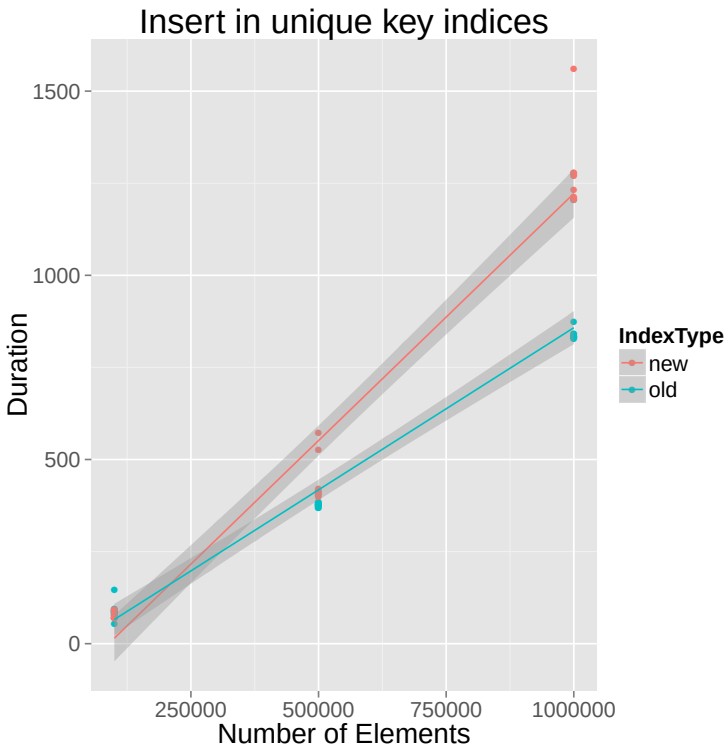
Index Implementation



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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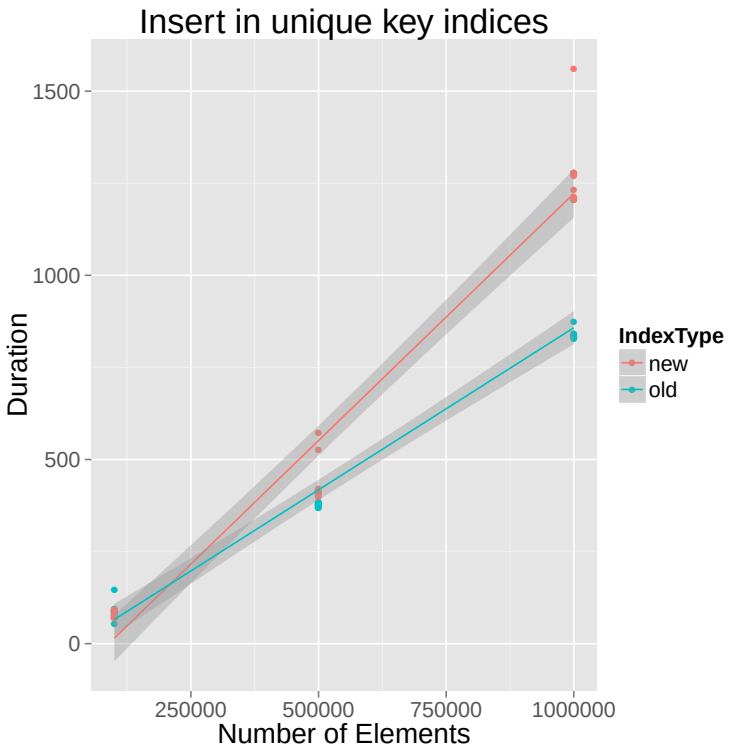

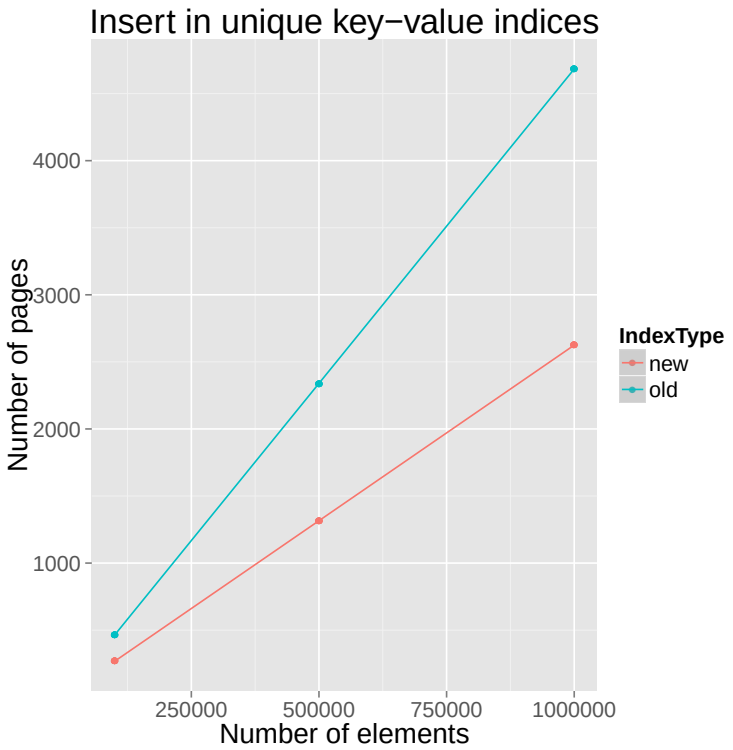

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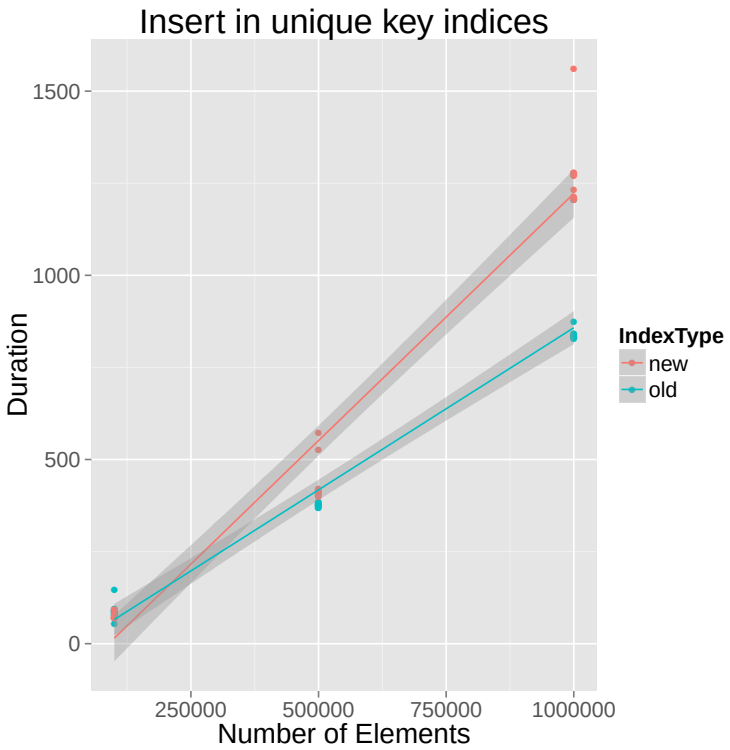

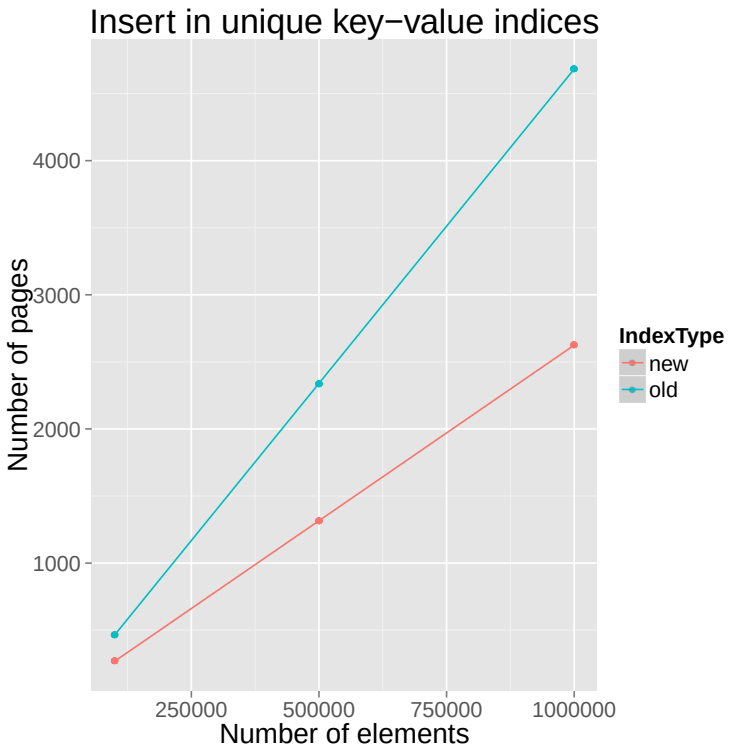

- in every microbenchmark the new index is significantly slower
- in most microbenchmarks there s a significantly lower number of nodes

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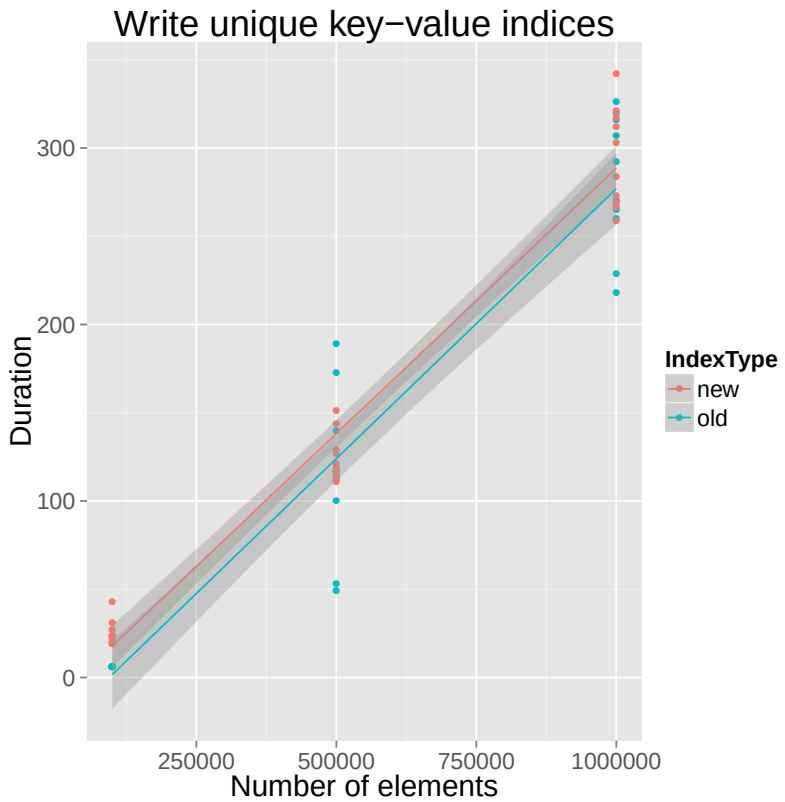
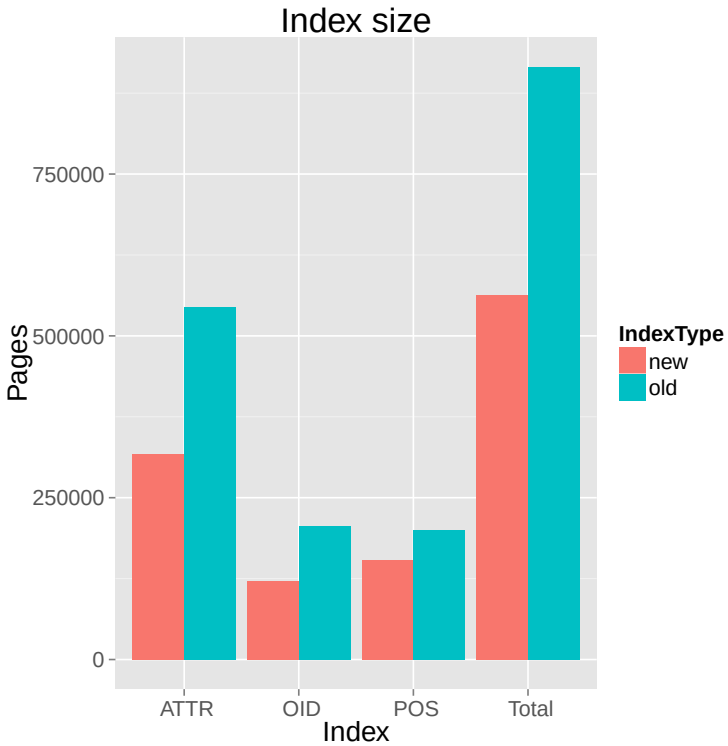


StackOverflow Import



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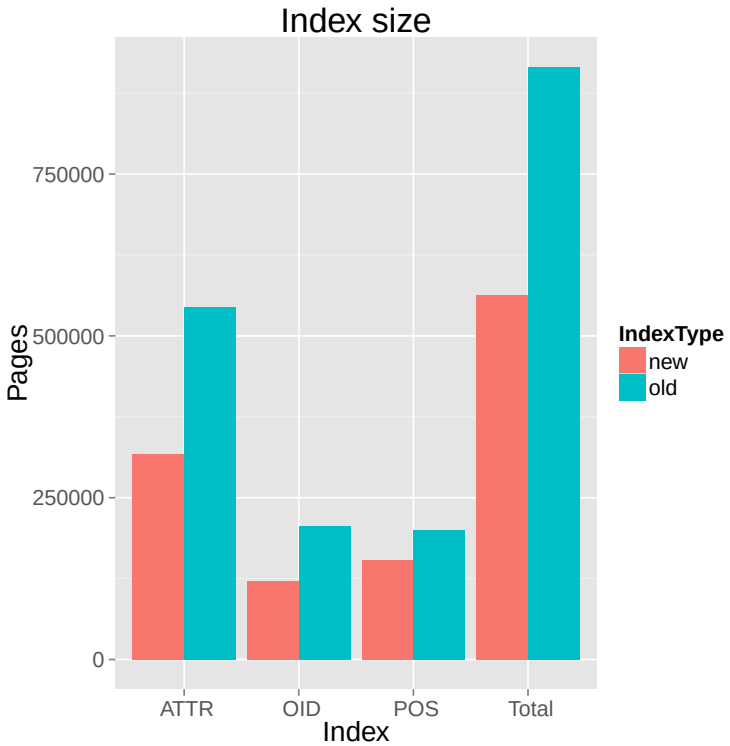

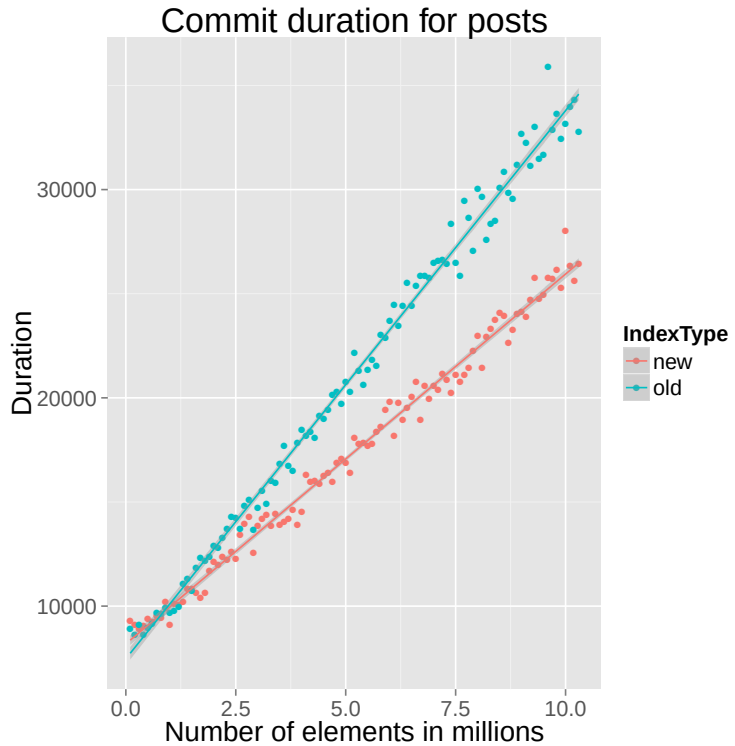

Summary

- ...

Outlook

- ...