Designing an Index for ZooDB

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May 31, 2014

Outline

1 Introduction

2 Goals & Challenges

3 The new Index Implementation

4 Benchmarks

- 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

1. **fast** retrieval
2. **ordered** iteration
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Attribute Index
Value $\rightarrow$ Object-ID

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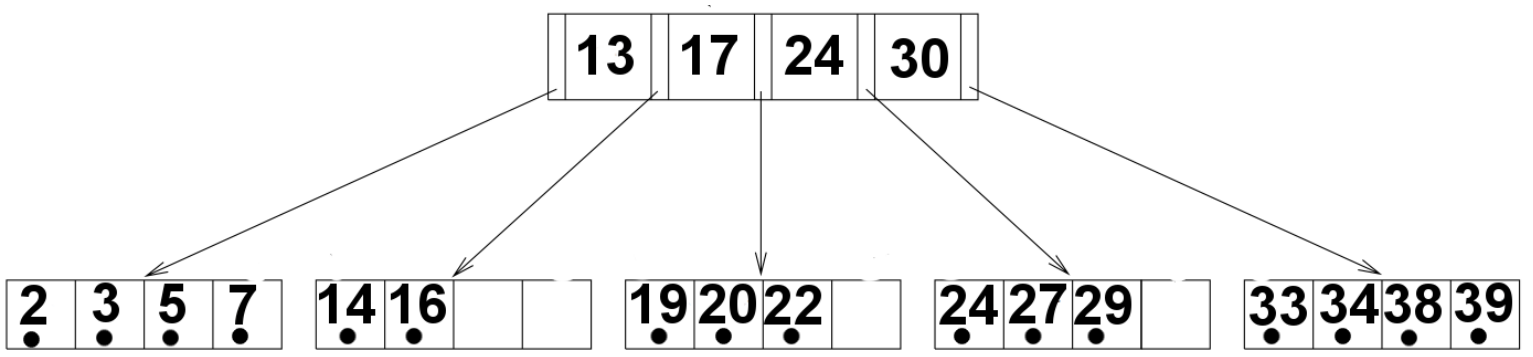
Attribute Index	ObjectID Index	Free Space Index
Value → Object-ID	OID → Diskpos	Page-ID → TxID

B+ Tree

Images adapted from Database Management Systems by Ramakrishnan and Gehrke.

B+ Tree



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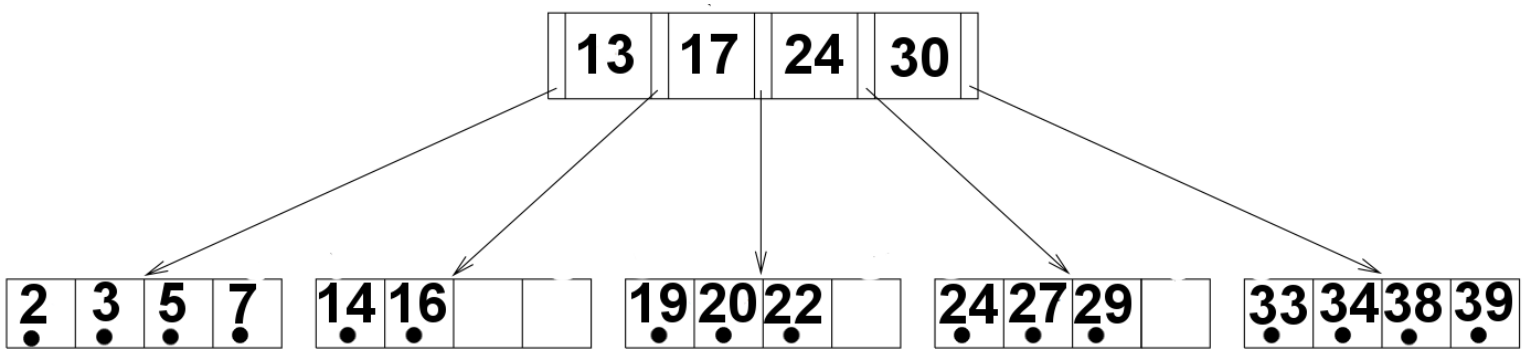

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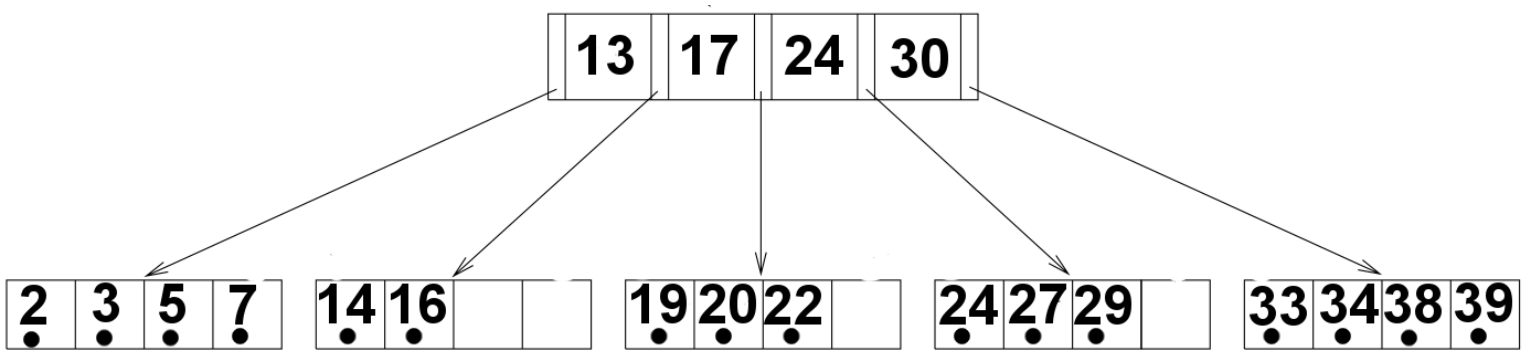

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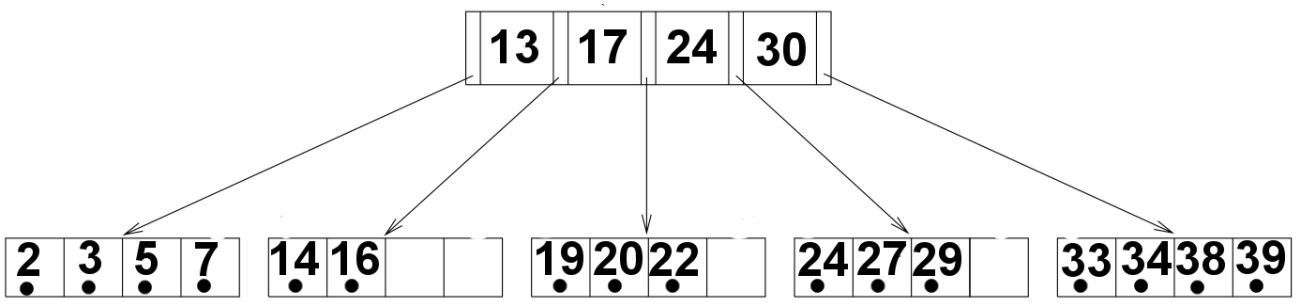

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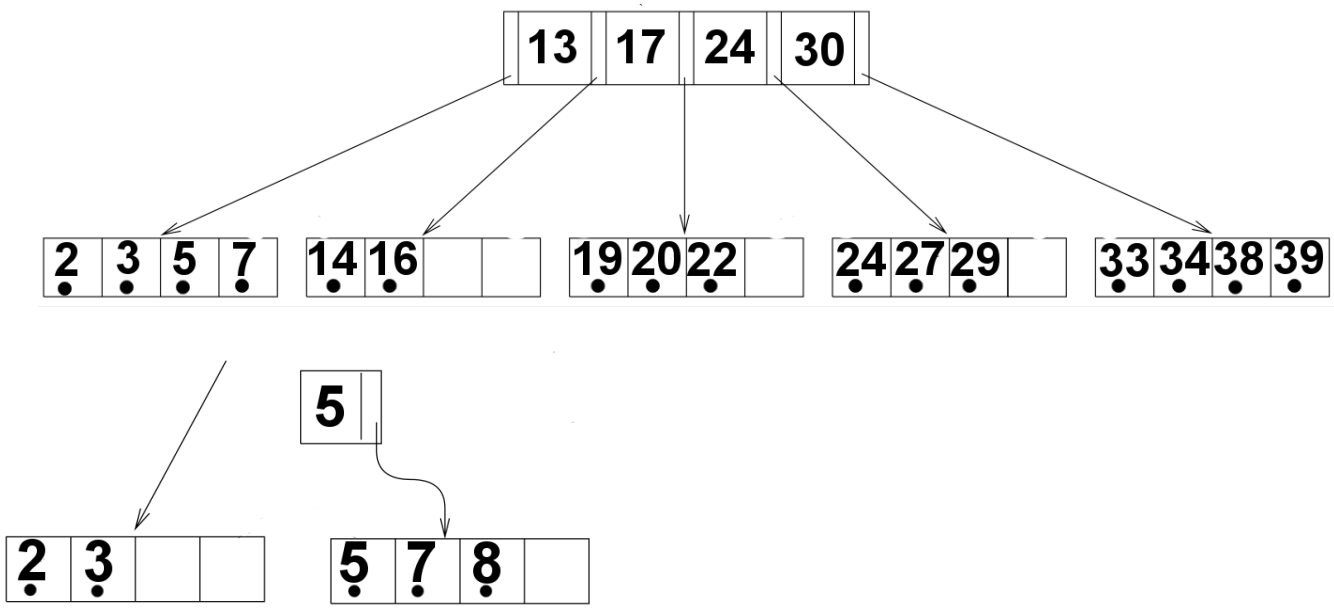

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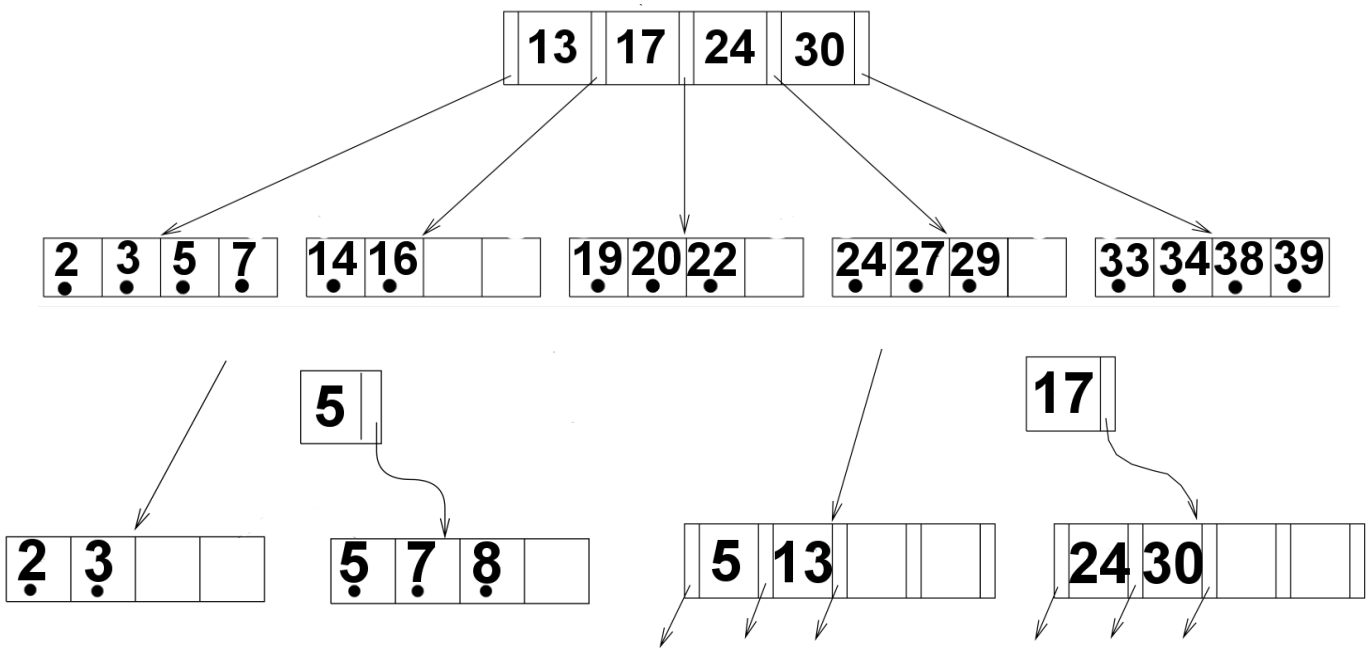

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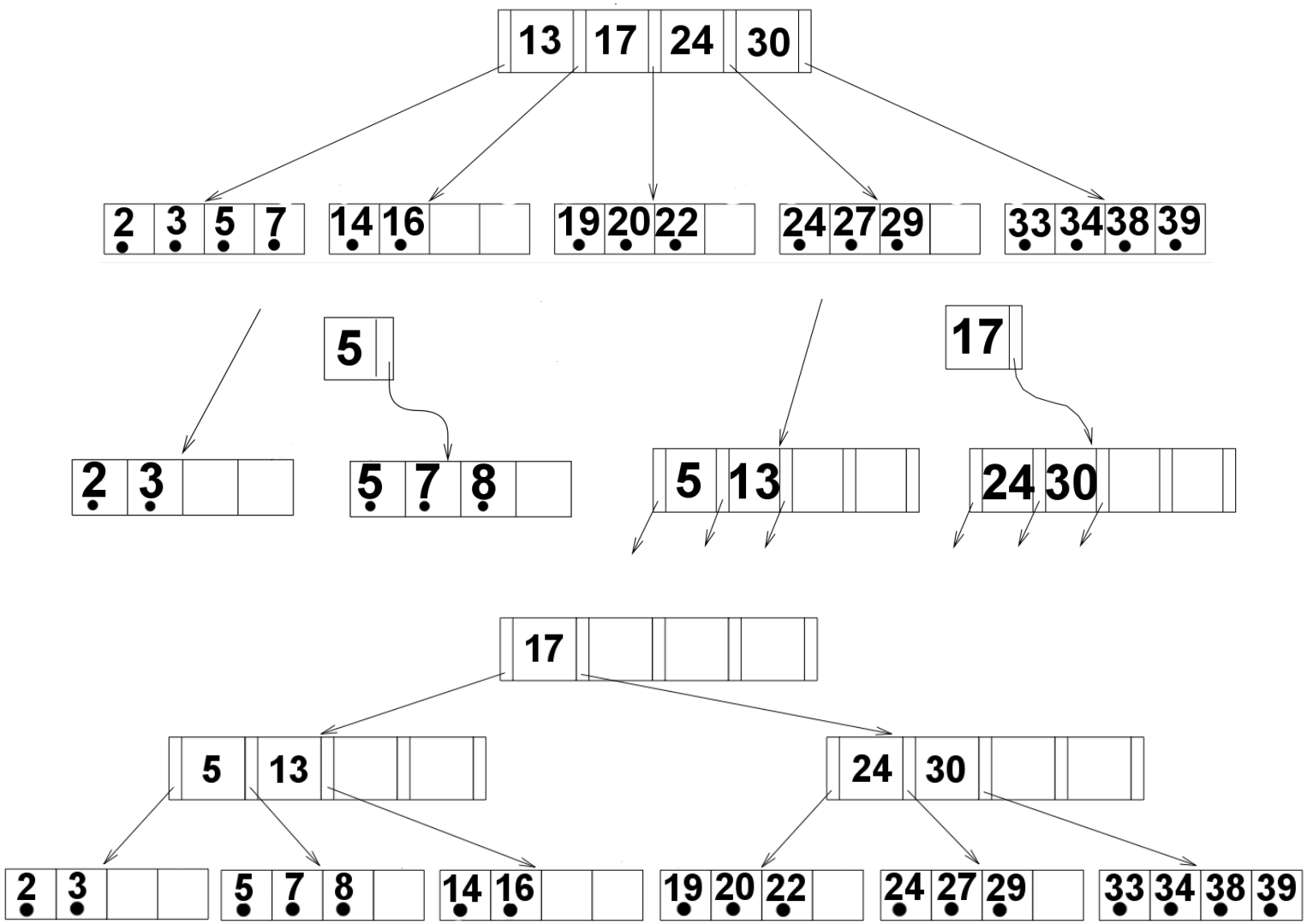

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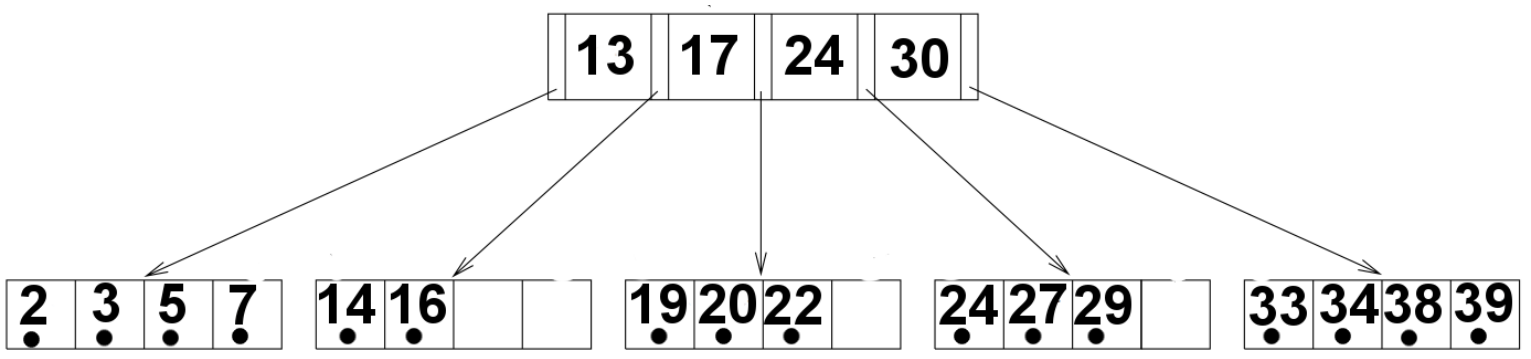

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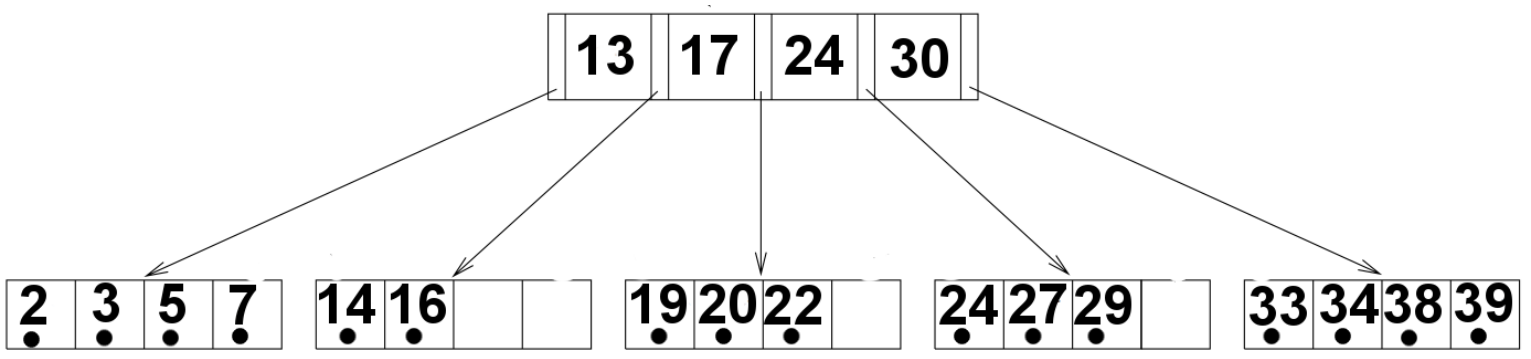

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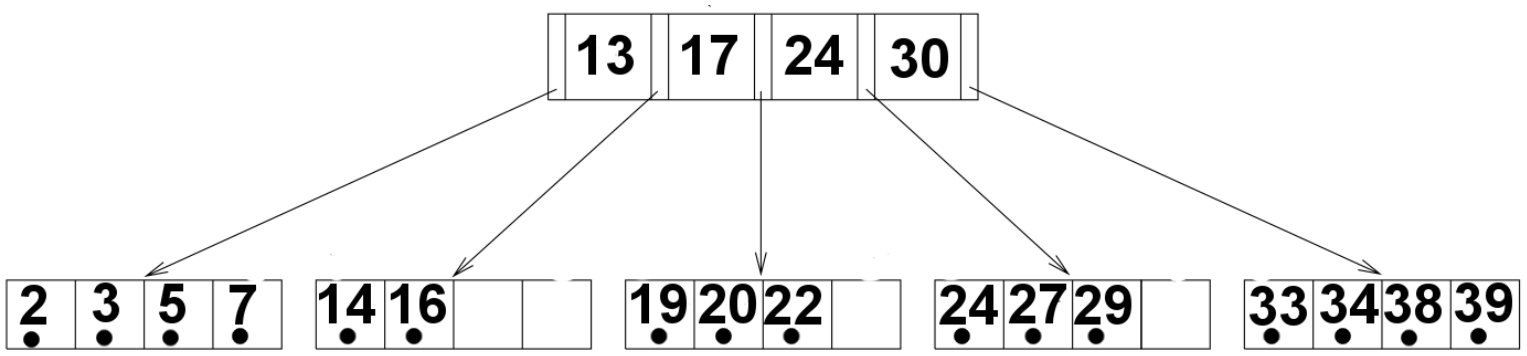

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- Insert, remove, search are logarithmic.

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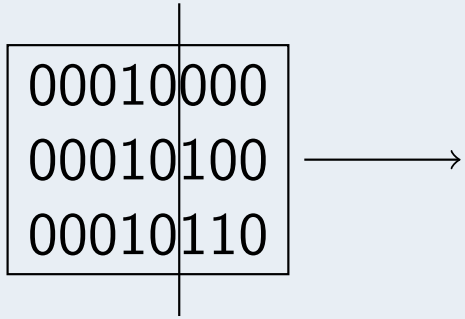

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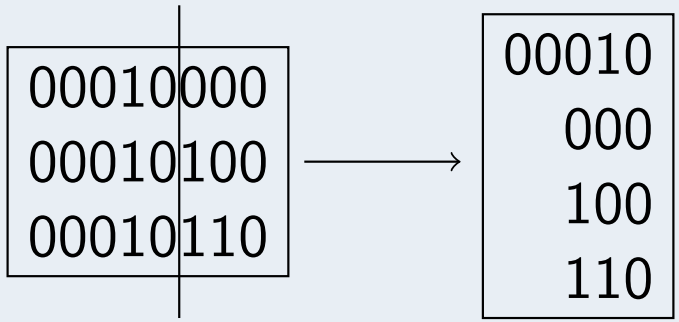

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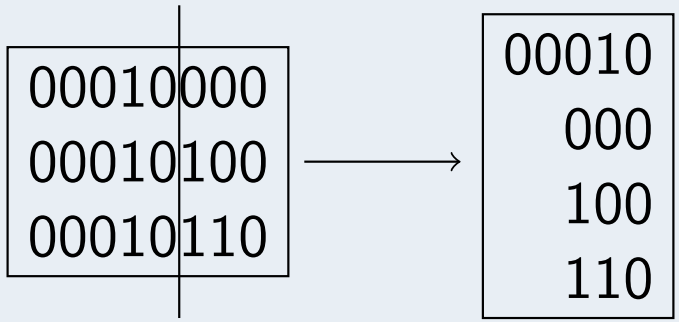

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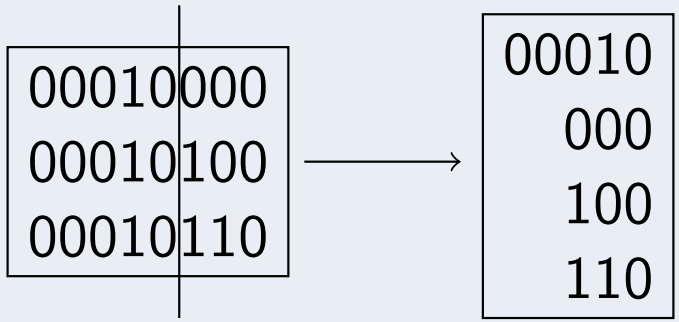

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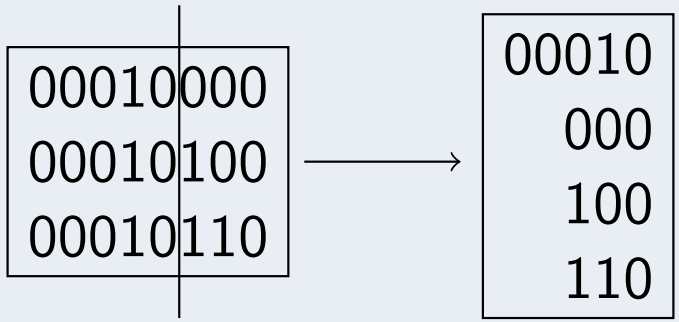

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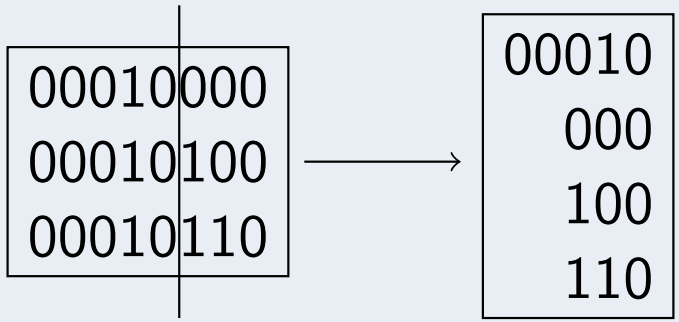

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- prefix determines
  - if can be split without underflow
  - if can be merged without overflow
  - the number redistributions

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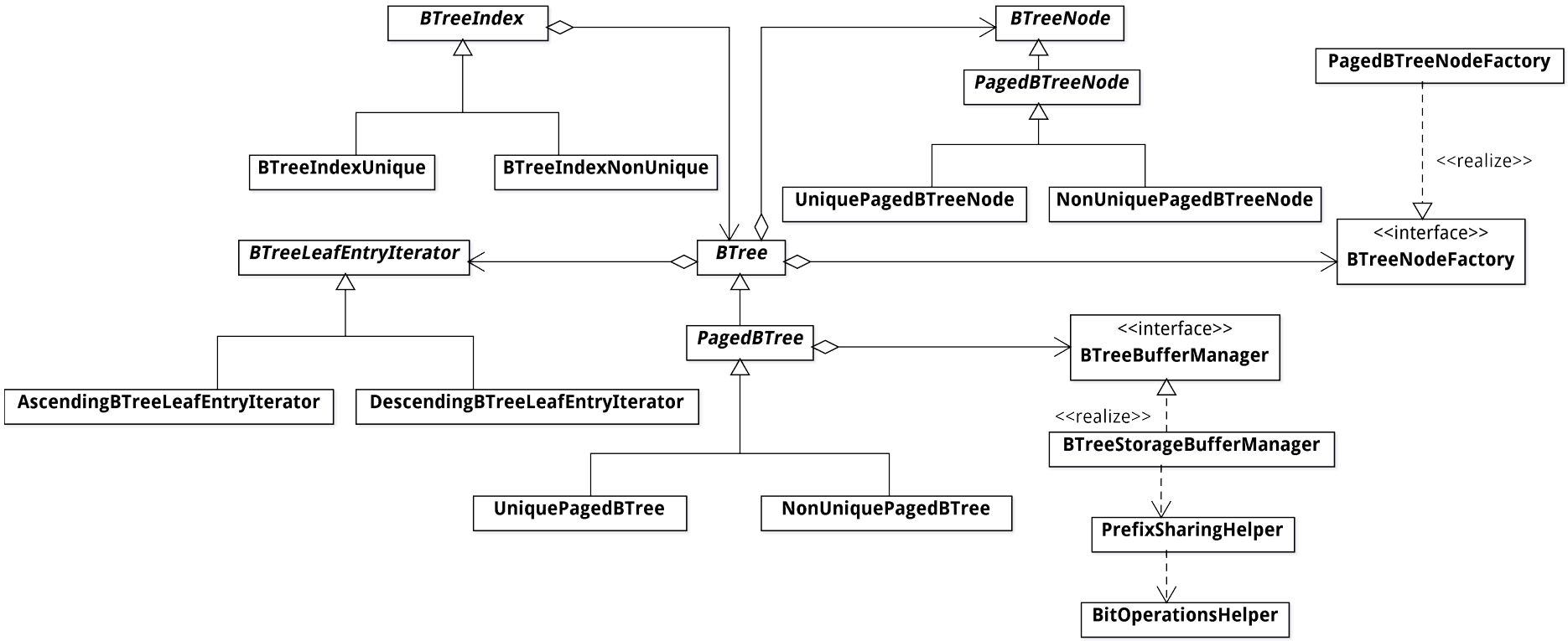
- low-level implementation optimizations

Index Implementation



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- Write
  - only write dirty nodes
  - prefix encoding

Microbenchmarks

Duration

Operation	Baseline (No prefix sharing)	Prefix sharing
Search	1	0.9 - 1.1
Insert	1	1.6 - 2.8
Delete	1	1.45 - 2.9

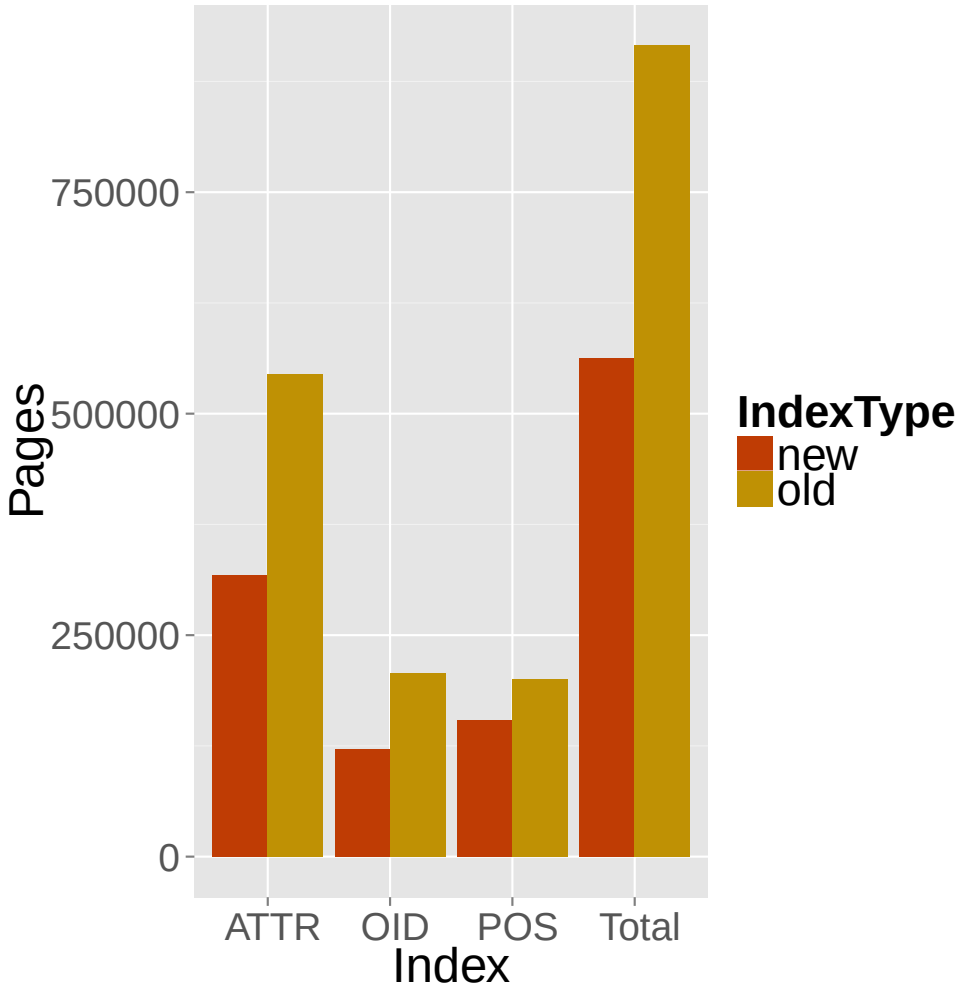
Size of B+ tree

Operation	Baseline (No prefix sharing)	Prefix sharing
Insert	1	0.5 - 1.1
Delete	1	0.5 - 0.75

StackOverflow Data Import

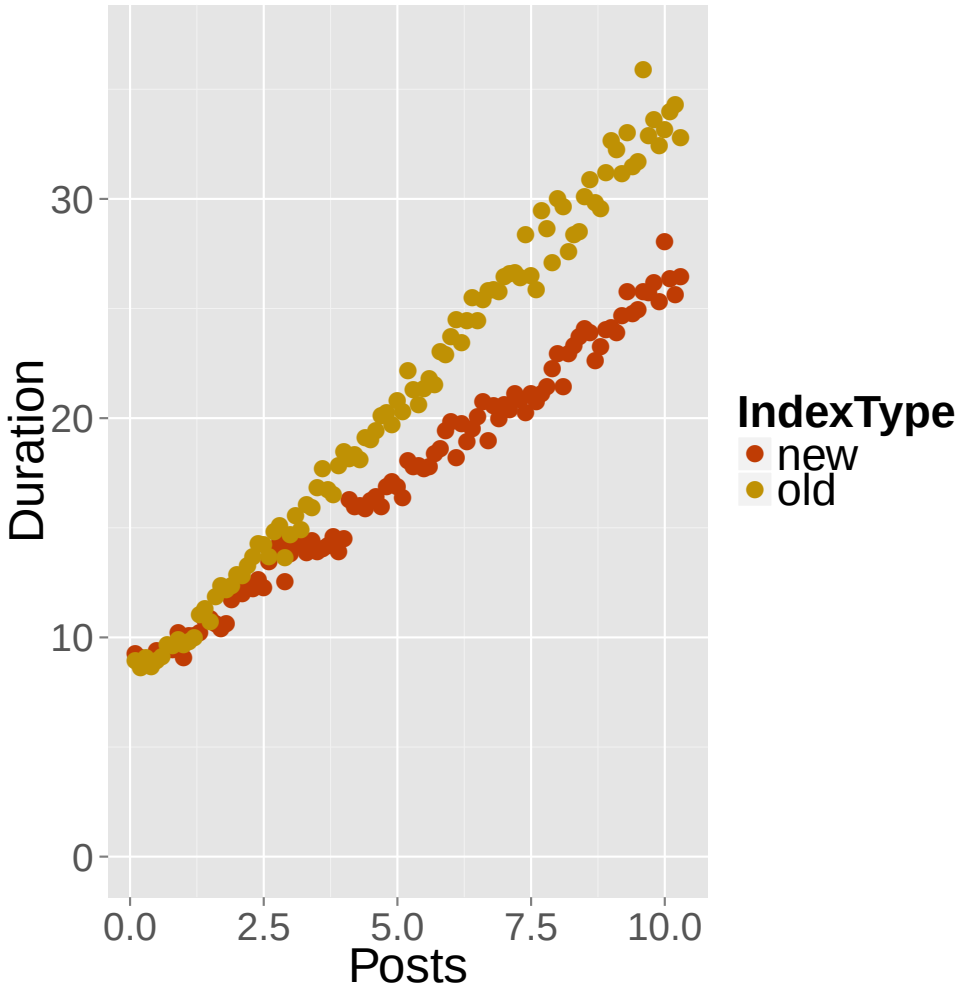
- Real-world workload consisting of importing StackOverflow dump
- 1.3 million users, 10.3 million posts, 13 million comments comments and 25 million votes
- 3 key unique attribute indexes
- 9 key-value unique indexes

StackOverflow Import - Index Sizes



Index	**Space saving** (%)
Atrribute	41.6
OID	41.5
POS	23.1
Total	38.5

StackOverflow Import - Commit times



- predominantly searches
- more entries in a node
  $\rightarrow$ fewer dirty nodes
- data locality

Summary

- Prefix sharing: tradeoff between speed and space
- Microbenchmarks
- Implementation complexity.

Q&A

- Thank you for your attention!
- Questions ?