

# R-trees

## A Programmer's Introduction

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# Introduction

- 1 What is an R-tree?
- 2 What are R-trees useful for?

- 1 Balancing
  - 1 Root node
  - 2 Leaf nodes
  - 3 Internal nodes
- 2 Tightness
  - 1 Leaf nodes
  - 2 Internal nodes
- 3 Leaf depth equality

# Tree depth

The branching factor of each level of an R-tree is at least  $m$ , and at most  $M$ , so:

$$\lceil \log_m N \rceil - 1 \leq \text{depth} \leq \lceil \log_M N \rceil - 1$$

So:

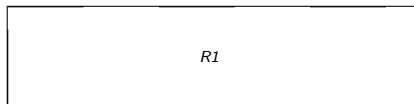
$N$	$m$	$M$	Bound (inclusive)
4	1	2	1-3
4	2	4	0-1
32	4	8	1-2
25,000	15	50	2-3
25,000	2	15	3-4
100,000	2	4	8-16

- 1 Tree depth is low: why are lookups remotely expensive?

- ① *Search*
- ② *Insert*
  - ① *AdjustTree*
- ③ *Delete*
  - ① *CondenseTree*
- ④ *SplitNode*

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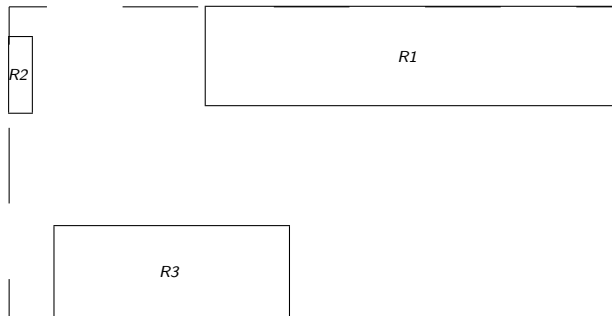


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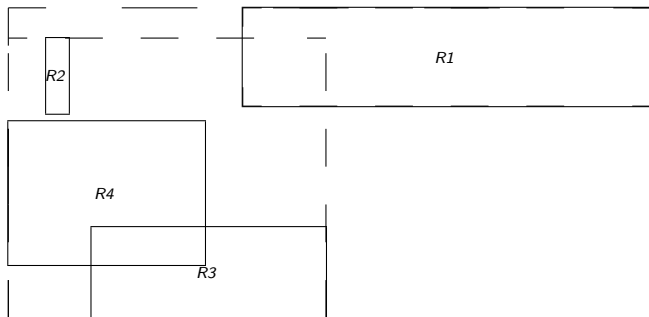




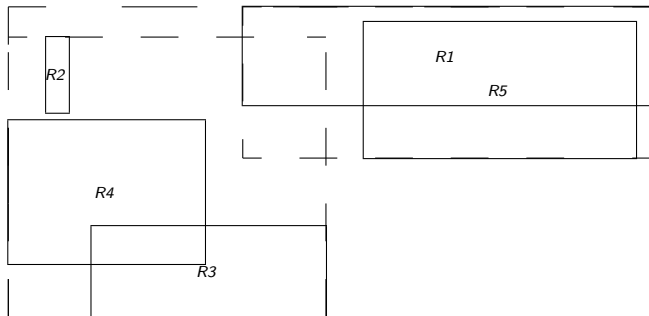
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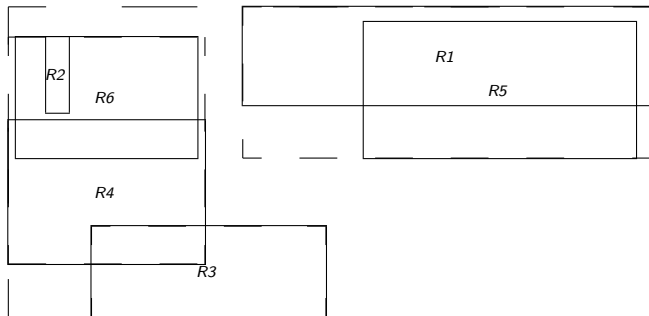
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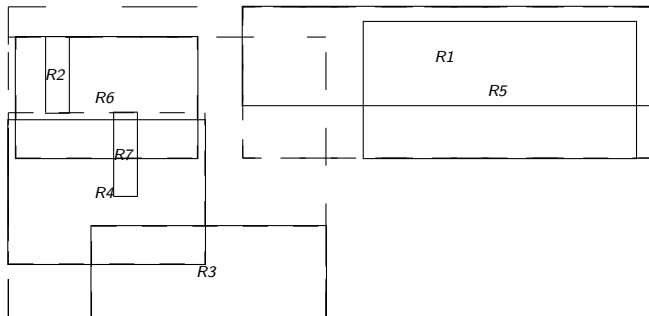
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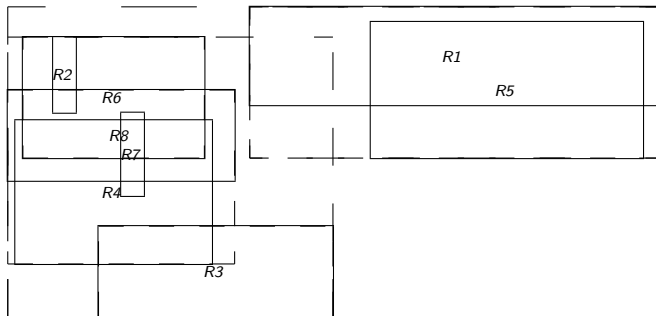
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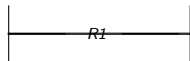
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# R-tree example ( $m = 2, M = 4$ )

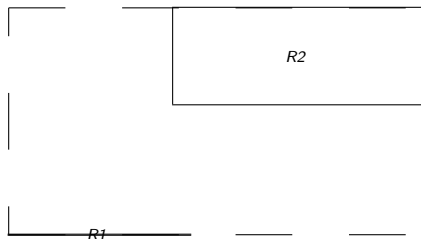
4

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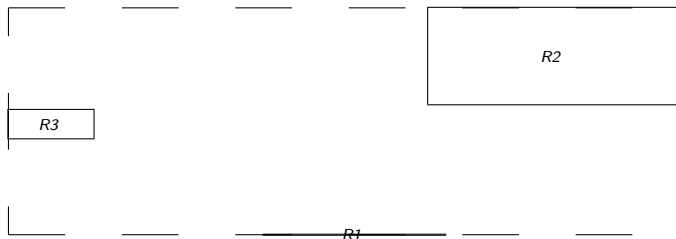




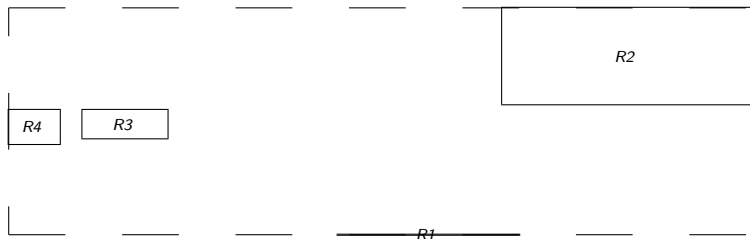
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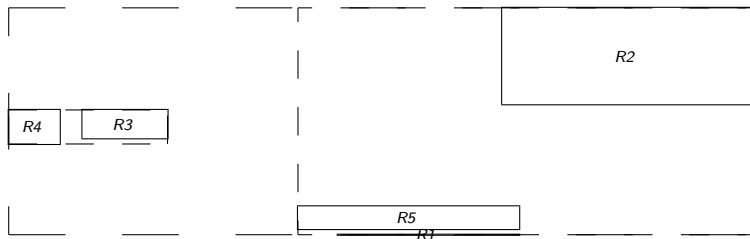
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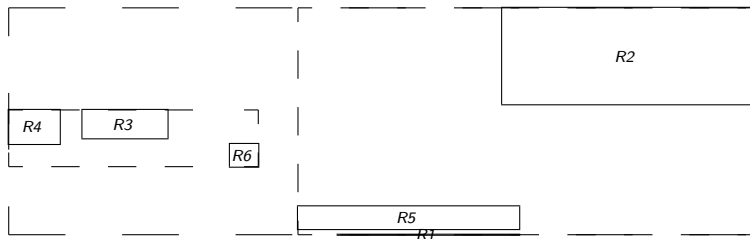
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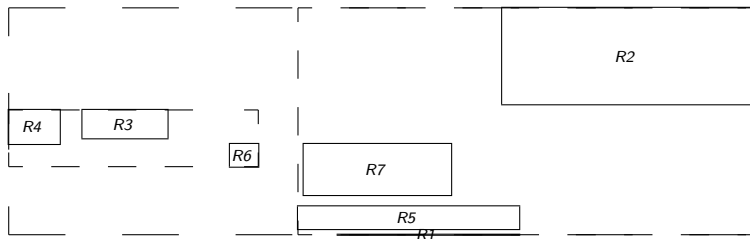
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