CS2055 HW8

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1. Extendible hashing structure:

Global: (3)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 000 | 001 | 010 | 011 | 100 | 101 | 110 | 111 |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 0 (1) | 111 (3) | 011 (3) | 101 (3) | 001 (3) |
| 2\* (10)  20\* (10100)  4\* (100) | 31\* (11111)  7\* (111)  23\* (10111) | 11\* (1011)  3\* (011)  19\* (10011) | 29\* (11101)  13\* (1101)  5\* (101) | 9\* (1001)  17\* (10001)  25\* (11001) |

1. B+ tree:

After inserting 7:

|  |  |  |
| --- | --- | --- |
| 5 |  |  |

|  |  |  |
| --- | --- | --- |
| 2 | 3 |  |

|  |  |  |
| --- | --- | --- |
| 5 | 7 |  |

After inserting 17:

|  |  |  |
| --- | --- | --- |
| 5 | 8 |  |

|  |  |  |
| --- | --- | --- |
| 8 | 17 |  |

|  |  |  |
| --- | --- | --- |
| 2 | 3 |  |

|  |  |  |
| --- | --- | --- |
| 5 | 7 |  |

After inserting 19:

|  |  |  |
| --- | --- | --- |
| 5 | 8 | 17 |

|  |  |  |
| --- | --- | --- |
| 2 | 3 |  |

|  |  |  |
| --- | --- | --- |
| 5 | 7 |  |

|  |  |  |
| --- | --- | --- |
| 8 | 15 |  |

|  |  |  |
| --- | --- | --- |
| 17 | 19 |  |

After inserting 29:

|  |  |  |
| --- | --- | --- |
| 17 |  |  |

|  |  |  |
| --- | --- | --- |
| 5 | 8 |  |

|  |  |  |
| --- | --- | --- |
| 20 |  |  |

|  |  |  |
| --- | --- | --- |
| 2 | 3 |  |

|  |  |  |
| --- | --- | --- |
| 5 | 7 |  |

|  |  |  |
| --- | --- | --- |
| 8 | 11 | 15 |

|  |  |  |
| --- | --- | --- |
| 17 | 19 |  |

|  |  |  |
| --- | --- | --- |
| 20 | 29 |  |

1. B+ steps:
2. delete 2:

|  |  |  |
| --- | --- | --- |
| 17 |  |  |

|  |  |  |
| --- | --- | --- |
| 8 |  |  |

|  |  |  |
| --- | --- | --- |
| 20 |  |  |

|  |  |  |
| --- | --- | --- |
| 3 | 5 | 7 |

|  |  |  |
| --- | --- | --- |
| 8 | 11 | 15 |

|  |  |  |
| --- | --- | --- |
| 17 | 19 |  |

|  |  |  |
| --- | --- | --- |
| 20 | 29 |  |

1. Delete 19

|  |  |  |
| --- | --- | --- |
| 8 | 17 |  |

|  |  |  |
| --- | --- | --- |
| 17 | 20 | 29 |

|  |  |  |
| --- | --- | --- |
| 3 | 5 | 7 |

|  |  |  |
| --- | --- | --- |
| 8 | 11 | 15 |

Delete 3 and 5:

|  |  |  |
| --- | --- | --- |
| 11 | 17 |  |

|  |  |  |
| --- | --- | --- |
| 17 | 20 | 29 |

|  |  |  |
| --- | --- | --- |
| 11 | 15 |  |

|  |  |  |
| --- | --- | --- |
| 7 | 8 |  |

1. Number of levels:

Since for a b+-tree with max pointers as 9, at level d the maximum total amount of the nodes is 9^d. Since there are maximum 8 keys in each node, the total number of leaves is 9^d \* 8. This happens when each node is full. Thus, given a certain number of leaves, the fuller the nodes are the fewer the levels there are in the tree. Thus, we will calculate the number of levels when each node has 9 child nodes, which will be log9(5127 / 8) = 2.94136, which rounds to 3.

5.

a.

H1=R3(z)W2(x)R2(z)W2(y)R1(x)R3(x)R3(y)W1(x)

Conflicting ops:

W2(x) < R1(x) W2(x) < R3(x) W2(x) < W1(x)

W2(y) < R3(y)

H2=W2(x)W2(y)W1(x)R3(x)R1(x)R3(z)R3(y)R2(z)

Conflicting ops:

W2(x) < W1(x) W2(x) < R3(x) W2(x) < R1(x)

W2(y) < R3(y)

W1(x) < R3(x)

H3=W2(y)W2(x)W1(x)R3(y)R2(z)R1(x)R3(x)R3(z)

Conflicting ops:

W2(y) < R3(y)

W2(x) < W1(x) W2(x) < R1(x) W2(x) < R3(x)

W1(x) < R3(x)

H4=R3(y)W2(y)R2(z)W1(x)R3(x)W2(x)R3(z)R1(x)

Conflicting ops:

R3(y) < W2(y)

W1(x) < R3(x) W1(x) < W2(x)

R3(x) < W2(x)

W2(x) < R1(x)

H2 and H3 have their conflicting operations in the same order.

They are conflict equivalent

b.

H1=R3(z)W2(x)R2(z)W2(y)R1(x)R3(x)R3(y)W1(x)

W2(x) < R1(x): T2 -> T1

W2(x) < R3(x): T2 -> T3

Serializable, serial history: T2 -> T1 -> T3

H2=W2(x)W2(y)W1(x)R3(x)R1(x)R3(z)R3(y)R2(z)

W2(x) < W1(x): T2 -> T1

W2(x) < R3(x): T2 -> T3

W1(x) < R3(x): T1 -> T3

Serializable, serial history: T2 -> T1 -> T3

H3=W2(y)W2(x)W1(x)R3(y)R2(z)R1(x)R3(x)R3(z)

W2(y) < R3(y): T2 -> T3

W2(x) < W1(x): T2 -> T1

W1(x) < R3(x): T1->T3

Serializable, serial history: T2 -> T1 -> T3

H4=R3(y)W2(y)R2(z)W1(x)R3(x)W2(x)R3(z)R1(x)

R3(y) < W2(y): T3 -> T2

W1(x) < R3(x): T1 -> T3

W1(x) < W2(x): T1 -> T2

R3(x) < W2(x): T3 -> T2

Not serializable

c. H2, H3

H1=R3(z)W2(x)R2(z)W2(y)R1(x)R3(x)R3(y)W1(x)

T1 T2 T3

wlock(x)

rlock(z)

rlock(x)

rlock(z)

R3(z)

W2(x)

R2(z)

wlock(y)

W2(y)

R1(x)

R3(x)

R3(y)

W1(x)