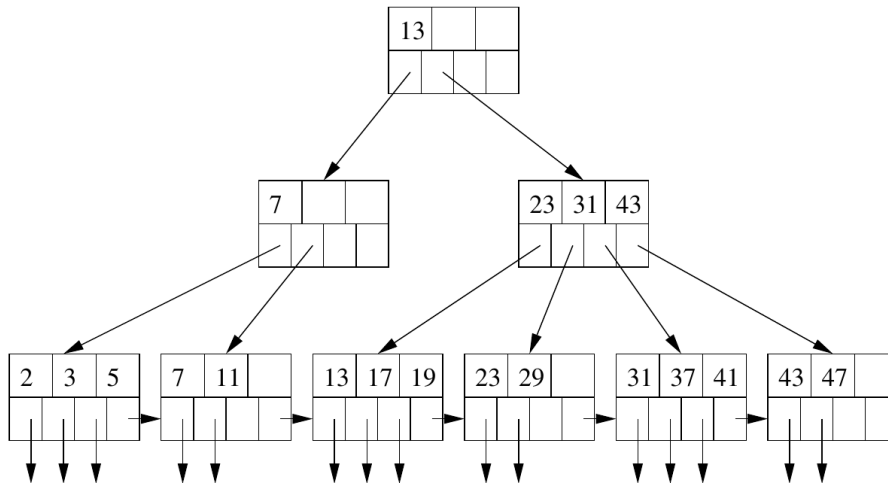


Database Management Systems, Aug–Dec 2023
Assignment 5, 25 November 2023, due 3 December 2023

1. The B+-tree below has 3 keys and 4 pointers per node. The values in each node are arranged

as

K_1	K_2	K_3	
P_1	P_2	P_3	P_4



- (a) Draw the tree after inserting a new key 40.
 - (b) Draw the tree after deleting key 7 (in the original tree, without having inserted 40).
2. Consider relations $r_1(A, B, C)$ and $r_2(C, D, E)$. We wish to compute $r_1 \bowtie r_2$, the natural join of r_1 and r_2 . Explain the difference in efficiency in computing this join under the following two assumptions:
- (a) A is a primary key for r_1 , there is no primary key for r_2 .
 - (b) C is a primary key for r_2 , there is no primary key for r_1 .
3. Let relations $r_1(A, B, C)$ and $r_2(C, D, E)$ have the following properties: r_1 has 6×10^6 tuples, r_2 has 3×10^6 tuples, 15 tuples of r_1 fit in one block, 30 tuples of r_2 fit in one block and the memory can hold approximately 100 blocks.
- Estimate the number of block accesses required using the following strategies for $r_1 \bowtie r_2$. Assume that neither r_1 nor r_2 is already sorted with respect to any of its attributes. Explain your answer, including your choice of outer and inner relations.
- (a) Nested-loop join
 - (b) Block nested-loop join

Database Management Systems, Aug–Dec 2023
Assignment 5, 25 November 2023, due 3 December 2023

4. Consider the following schedules of concurrent read and write operations.

Schedule A					Schedule B				
T_a	T_b	T_c	T_d	T_e	T_a	T_b	T_c	T_d	T_e
	$w(x_2)$					$w(x_2)$			
$w(x_1)$			$w(x_3)$		$w(x_1)$			$r(x_1)$	
	$r(x_1)$			$r(x_1)$		$r(x_1)$			$r(x_1)$
			$r(x_2)$					$r(x_2)$	
				$w(x_4)$					$w(x_4)$
		$r(x_4)$					$r(x_4)$		
$r(x_3)$		$r(x_3)$			$r(x_3)$		$r(x_3)$		
			$r(x_4)$					$r(x_4)$	
	$r(x_4)$					$r(x_4)$			

- (a) One of these schedules is conflict-serializable and the other is not. Explain which is which.
- (b) For the schedule that is conflict-serializable, list out all possible serial schedules that are consistent with this schedule.
5. Describe a concurrent schedule for the following two transactions T_1 and T_2 that is serializable, but not *conflict serializable*. Explain your answer.

T_1 : **read**(A);
 $A := A - 50$;
write(A);
read(B);
 $B := B + 50$;
write(B).

T_2 : **read**(A);
 $temp := A * 0.1$;
 $A := A - temp$;
write(A);
read(B);
 $B := B + temp$;
write(B).