

Vitamin 4

now with more vitamin B+

B+ Trees

1. **Q1: Suppose that all nodes in our B+ tree have an order of 1605. What's the MAXIMUM number of records we can index with a B+ tree of height 4?**

Assume our B+ trees are laid out as in lecture.

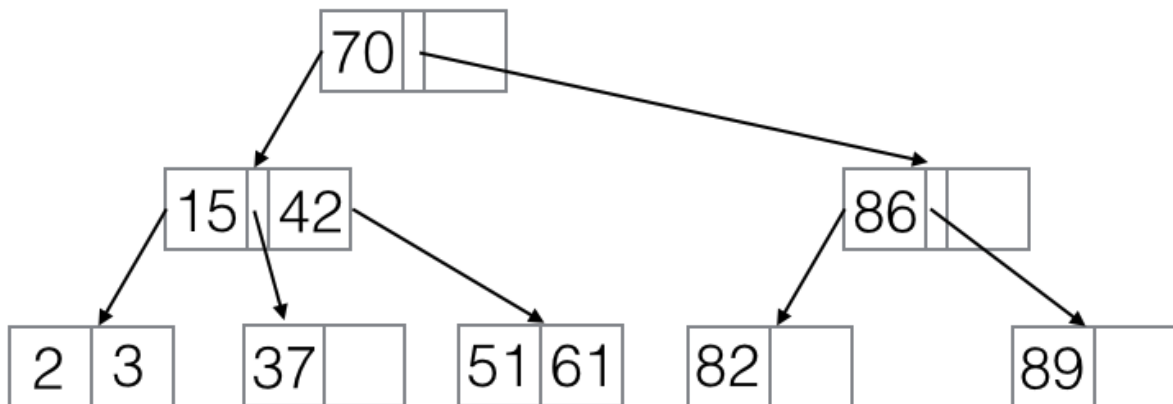
.....

2. **Q2: We want to bulk-load a B+ tree, and we reduce the fill-factor of this bulk load. Which of the following applies, in general?**

Check all that apply.

- ☐ The bulk loading operation is faster
- ☐ We consume more disk space
- ☐ A sequence of many consecutive record lookups is faster
- ☐ A sequence of many consecutive insertions requires fewer disk writes

Figure A



3. **Q3: We insert the key 55 into the B+ tree in figure A. How many I/Os (page reads and writes) does this operation take?**

Assume we require zero page reads and one page write to create a new page from scratch. Also assume that we do no key redistribution. Exclude disk I/Os done to data pages. Finally, assume we have 20 pages of memory available for caching pages in memory after reading them.

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4. **Q4: After performing the insert in Q3, what's the maximum number of keys we can insert into the B+ tree in figure A without splitting the ROOT?**
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Relational Algebra

Recall from Vitamin 2 that we had the following schema (no change). Now let's look at some relational algebra!

```
Boats {  
  bid int,  
  color varchar(20),  
  primarykey(bid)  
}
```

```
Sailors {  
  sid int,  
  sname varchar(50),  
  primarykey(sid)  
}
```

```
Reserves {  
  sid int,  
  bid int,  
  r_date char(10),  
  primarykey(sid, bid, r_date),  
  foreignkey(sid) references Sailors,  
  foreignkey(bid) references Boats  
}
```

Recall that π is project, σ is select, \bowtie is join, and ρ is rename.

- A) $\pi_{sname}(\sigma_{color = 'pink'}(Reserves \bowtie Boats) \bowtie Sailors)$
 B) $\pi_{sname}(\pi_{sid}(\sigma_{color = 'pink'}(Reserves \bowtie Boats)) \bowtie Sailors)$
 C) $\pi_{sname}(\sigma_{color = 'pink'}(Reserves \bowtie Sailors) \bowtie Boats)$
 D) $\pi_{sname}(\sigma_{color = 'pink'}(Reserves \bowtie Boats \bowtie Sailors))$
 E) $\sigma_{color = 'pink'}(\pi_{sname}(Reserves \bowtie Boats) \bowtie Sailors)$
 F) $\sigma_{color = 'pink'}(\pi_{sname}(Reserves \bowtie Sailors) \bowtie Boats)$
 G) $\sigma_{color = 'pink'}(\pi_{sname}(Reserves \bowtie Boats \bowtie Sailors))$

5. **Q5: Which of the relational algebra(s) above describe(s) the name of all sailors who have reserved pink boats?**

Check all that apply
 Check all that apply.

- ☐ A
☐ B
☐ C
☐ D
☐ E
☐ F
☐ G

6. **Q6: Which one of the above expressions that is correct, if executed as a query plan, is the most performant?**

Mark only one oval.

- ☐ A
☐ B
☐ C
☐ D
☐ E
☐ F
☐ G

$\rho(temp, \pi_{bid}(\sigma_{color = 'blue'} Boats) \cap \pi_{bid}(\sigma_{r_date \geq '2016-01-01'}(Reserves \bowtie Boats)))$
 $\rho(result1, \pi_{sname}(Reserves \bowtie temp \bowtie Sailors))$
 $\rho(temp1, \pi_{sid}(\sigma_{color = 'blue'}(\sigma_{r_date \geq '2016-01-01'}(Reserves \bowtie Boats))))$
 $\rho(result2, \pi_{sname}(temp1 \bowtie Sailors))$
 $result1 - result2$

7. Q7: Which of the following *could* be in the output?

Recall that $B-A = \{x: x \text{ in } B \text{ and } x \text{ not in } A\}$. Choose all the options that could be in the set
Check all that apply.

- ☐ sailors who reserved blue boats but no other boats
- ☐ sailors who reserved boats in 2016 but only blue boats
- ☐ sailors who have only reserved boats after 2016
- ☐ sailors who have reserved blue boats that were reserved by others in 2016 but not the sailor him/herself in 2016

$$\begin{aligned} &\rho(temp1(sid1 \leftarrow sid), \pi_{color, sid}(Boats \bowtie Reserves)) \\ &\rho(temp2(sid2 \leftarrow sid), \pi_{color, sid}(Boats \bowtie Reserves)) \\ &\rho(temp3(sid3 \leftarrow sid), \pi_{color, sid}(Boats \bowtie Reserves)) \\ &\pi_{color}(\sigma_{(sid1 \neq sid2)} \sigma_{(sid1 \neq sid3)} \sigma_{(sid3 \neq sid2)}(temp1 \bowtie temp2 \bowtie temp3)) \end{aligned}$$

8. Q8: What does the algebra above yield?

Only one is correct
Mark only one oval.

- ☐ colors that have been chosen by at least three different sailors in their reservations
- ☐ colors that have been chosen by at least three sailors in their reservations
- ☐ the three most common boat colors among boats

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