STATIC INDEXES AND BITMAPS: SOLUTION

NDBI007: Practical Class 2

Based on NDBI007 practical class materials created by Petr Škoda; Tutor: Pavel Koupil; October 27th 2021

EXERCISE 1: PRIMARY KEY INDEX

- Build primary key index for a sequential file that contains 5,000,000 student records (of size 256 B)
  - Determine index height and compute the size of every index level

- You will have to compute blocking factor for the primary file in order to determine number of blocks N
  - Remember that the first (bottom) level points directly into the primary file N
- You will have to compute blocking factor for the primary index
  - Suppose page size equal to 4 kB and record size 9 B

- The number of pages on the next level can be computes as $n_{PAGES,L=i} = \lceil \frac{n_{PAGES,L=i-1}}{b} \rceil$

EXERCISE 1: PRIMARY KEY INDEX (SOLUTION)

- Blocking factor of primary file $b = \lfloor \frac{B}{R} \rfloor = \lfloor \frac{4 \bullet 2^{10}}{256} \rfloor = 16$
- Number of blocks of primary file $n_B = 5{,}000{,}000 \div 16 = 312{,}500$
- Blocking factor of primary key index $b_{ID} = \lfloor \frac{B}{R} \rfloor = \lfloor \frac{4 \bullet 2^{10}}{9} \rfloor = 455$

- Primary key index levels
  - The number of pages to index: 312, 500, level size: $n_{PAGES,L=i} = \lceil \frac{n_{PAGES,L=i-1}}{b} \rceil = \lceil \frac{312{,}500}{455} \rceil = 687$
  - The number of pages to index: 687, level size: $\lceil \frac{687}{455} \rceil = 2$
  - The number of pages to index: 2, level size: $\lceil \frac{2}{455} \rceil = 1$

EXERCISE 2: DIRECT INDEX

- Build direct index on firstName for a sequential file that contains 5,000,000 student records
  - Suppose that index record size is 20 B + 4 B (size of key + size of the pointer)
  - Determine index height and compute the size of every index level
  - Compare the structure with primary key index structure
    - I.e., number of levels, sizes of levels, total size of index (in MB)

EXERCISE 2: DIRECT INDEX (SOLUTION)

- Blocking factor $b_{FIRST\_NAME} = \lfloor \frac{B}{R} \rfloor = \lfloor \frac{4 \bullet 2^{10}}{24} \rfloor = 170$

- Direct index levels
  - Number of records in primary file: 5,000,000, level size: $\lceil \frac{5{,}000{,}000}{170} \rceil = 29{,}412$
  - Number of pages to address: 29,412, level size: $\lceil \frac{29{,}412}{170} \rceil = 174$
  - Number of pages to address: 174, level size: $\lceil \frac{174}{170} \rceil = 2$
  - Number of pages to address: 2, level size: $\lceil \frac{2}{170} \rceil = 1$

- The total size of index is $29{,}412 + 174 + 2 + 1 = 29{,}589$ so the total size is $29{,}589 \bullet 4\ kB \approx 115\ MB$
  - The size of this index is much larger than the size of the primary key index

EXERCISE 3: INDIRECT INDEX

- Build indirect index on secondName for a sequential file that contains 5,000,000 student records
  - Note that first level records and other level records differ in its size
    - First level: 25 B + 5 B (second name key size + primary key size)
    - Other level: 25 B + 4 B (second name key size + pointer to another page)
  - Determine index height and compute the size of every index level

EXERCISE 3: INDIRECT INDEX (SOLUTION)

- First level blocking factor is $b_{SECOND\_NAME,FIRST\_LEVEL} = \lfloor \frac{B}{R} \rfloor = \lfloor \frac{4 \bullet 2^{10}}{30} \rfloor = 136$
- Other level blocking factor is $b_{SECOND\_NAME,OTHER\_LEVELS} = \lfloor \frac{B}{R} \rfloor = \lfloor \frac{4 \bullet 2^{10}}{29} \rfloor = 141$

- Indirect index levels
  - Number of records to address: 5,000,000, level size: $\lceil \frac{5{,}000{,}000}{136} \rceil = 36{,}745$
  - Number of pages to address: 36,745, level size: $\lceil \frac{36{,}745}{141} \rceil = 261$
  - Number of pages to address: 261, level size: $\lceil \frac{261}{141} \rceil = 2$
  - Number of pages to address: 2, level size: $\lceil \frac{2}{141} \rceil = 1$