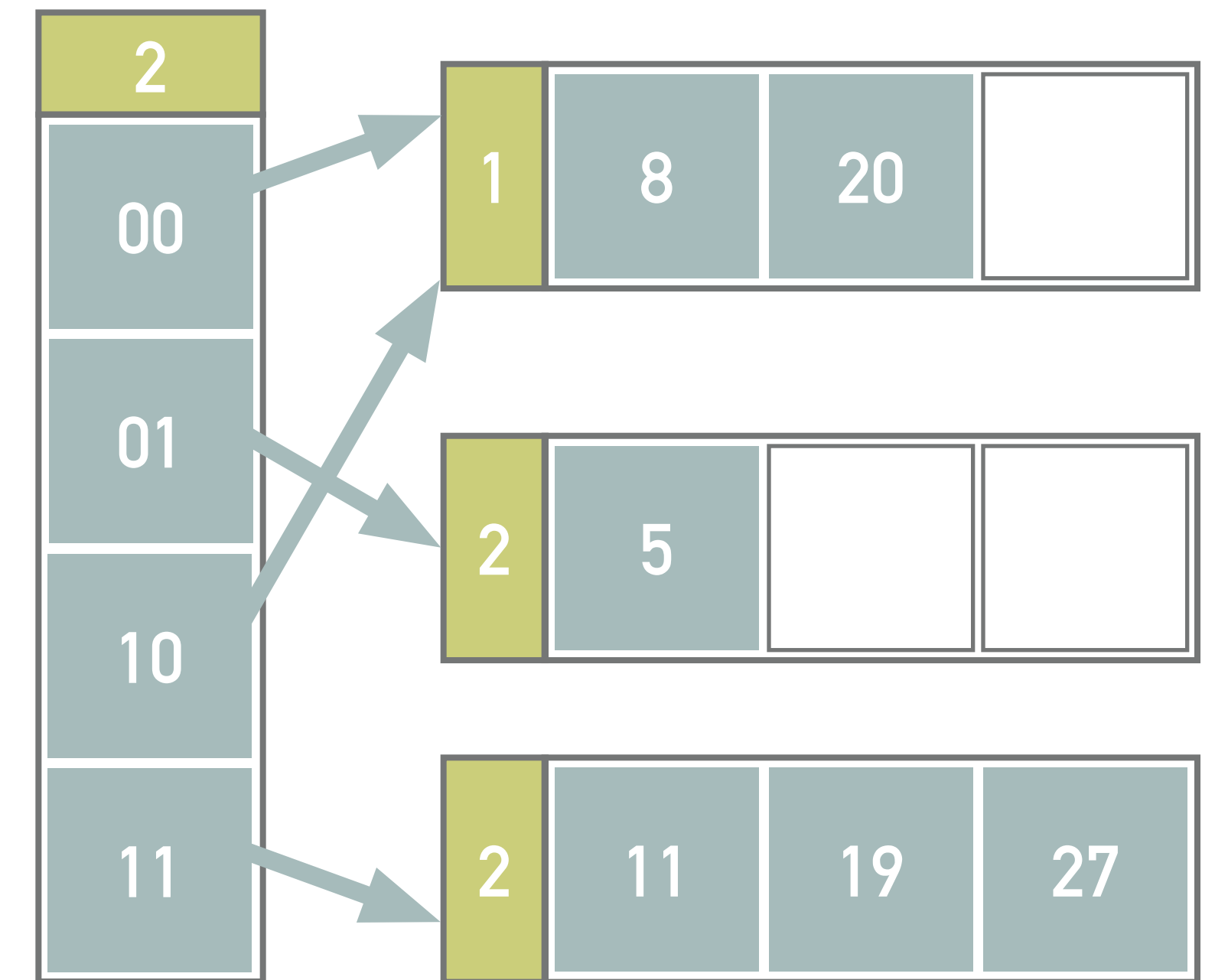# DYNAMIC HASHING: SOLUTION

NDBI007: Practical Class 4
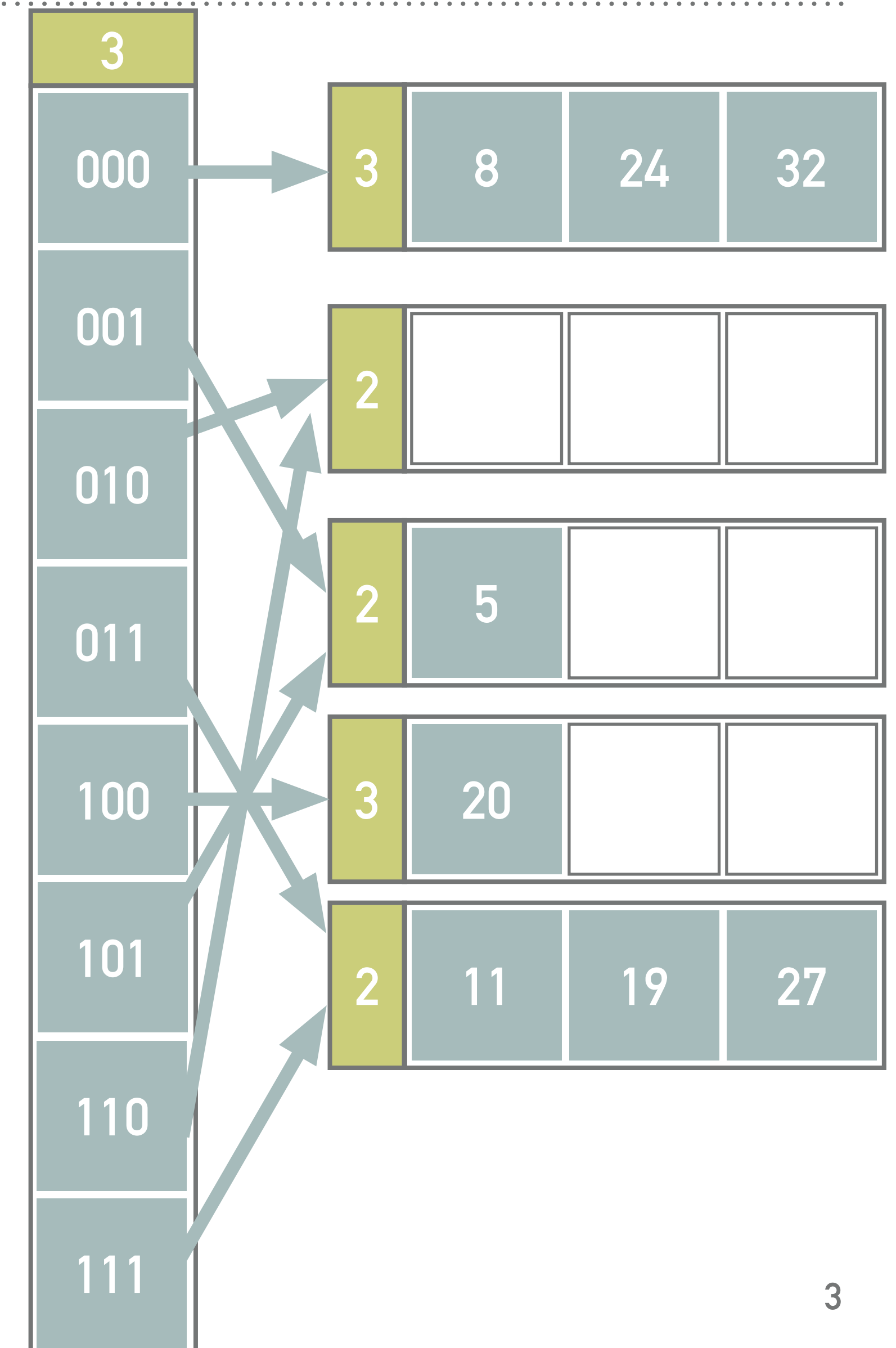
EXERCISE 1

➤ Insert records with keys 24 and 32

➤ Note all the computations and illustrate the solution

➤ $h(24_{10}) = 11000_2$

➤ $h(32_{10}) = 100000_2$

➤ The second insert splits ($d_L < d_G$) the page pointed by entry 0 into two pages pointed by entries 00, 01 respectively, and is incremented $d_L = 2$

➤ Still, all the keys 8, 20, 24, and 32 belong to the page pointed by entry 00, therefore additional split is needed

  ➤ $d_L = d_G = 2$, forcing the directory to be expanded to eight entries, i.e., global depth is incremented $d_G = 3$

  ➤ Subsequently, the page 00 is split to 000 and 100 and respective local depths are incremented to $d_L = 3$

  ➤ Finally, the records from split page are reinserted:

    ➤ Records with keys 8, 24, and 32 go into page 000

    ➤ Record with key 20 is accommodated in the page 100

3

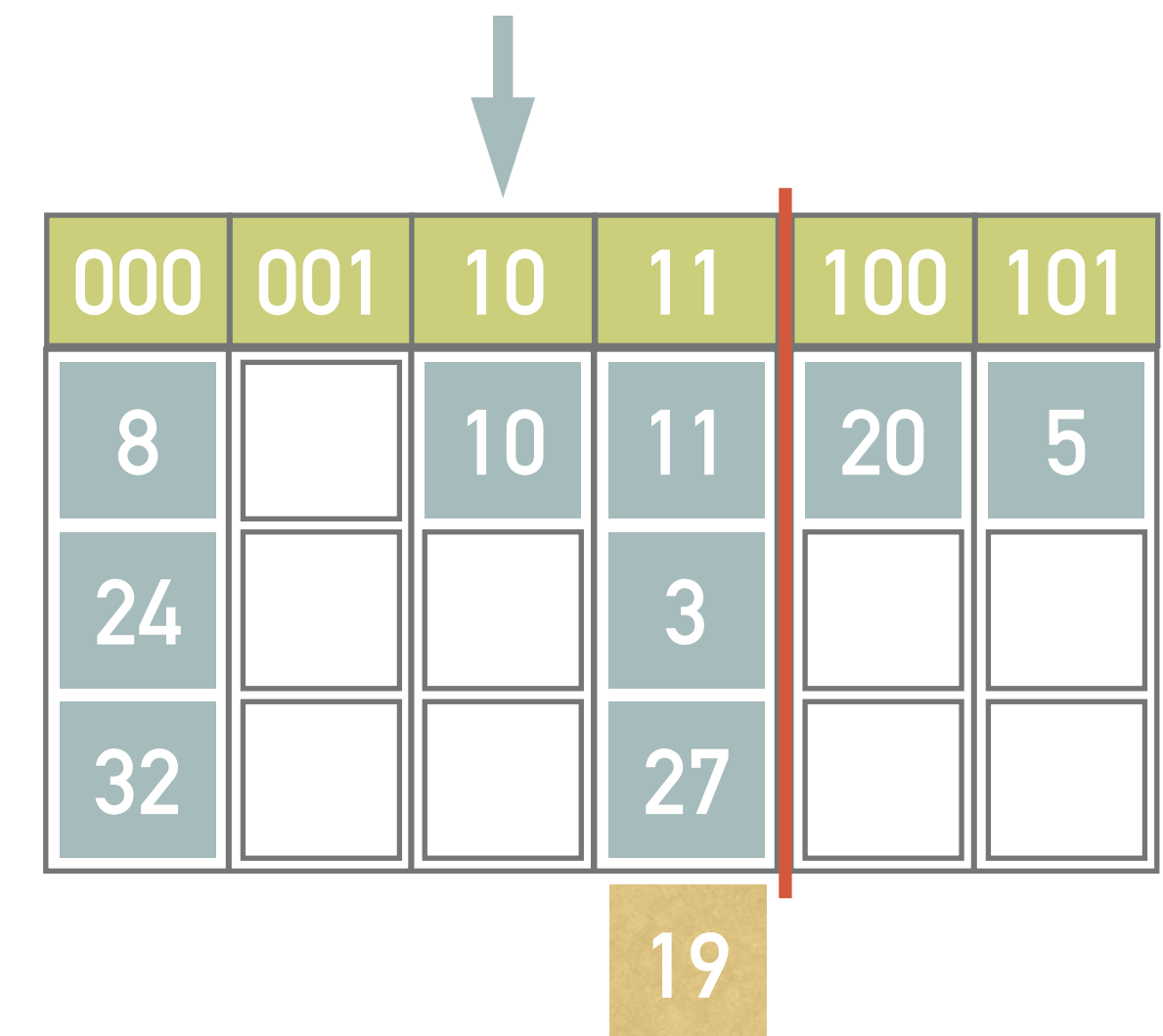➤ Insert records with keys 27, 19, 10, and 5 into the
following structure

  ➤ I.e., start the stage $d = 2$ with $s = 4$ pages (capacity 3
  records), $h(k) = k$, $p = 0$

  ➤ Pre-defined condition: Splitting occurs after 2 inserts

➤ Note all the computations and illustrate the solution

00	01	10	11
20			11
8			3
24			
32			
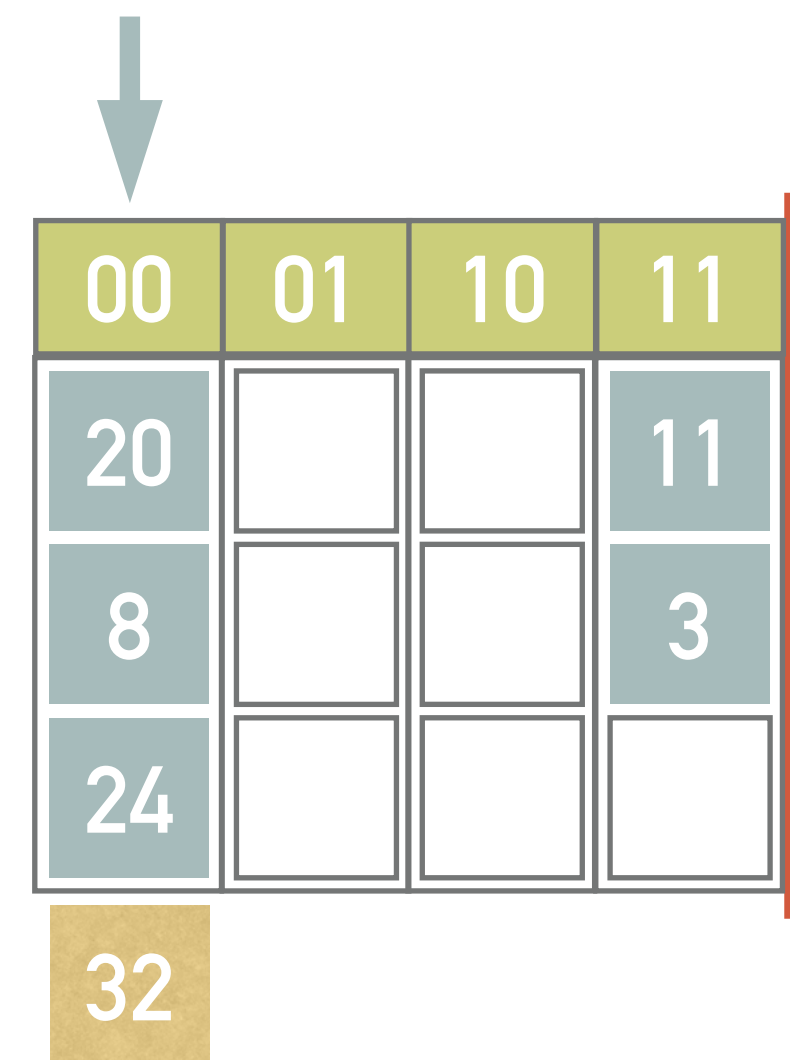
EXERCISE 2: SOLUTION

➤ The records with keys 27, 19 are inserted into the page 11

  ➤ $h(27_{10}) = 11011_2$

  ➤ $h(19_{10}) = 10011_2$

➤ We have already inserted 2 records in the stage $d = 2$, therefore page $p_0 = 00$ is split into pages $p_0 = 000$, $p_1 = 100$ and the records are redistributed into the new pages, $p = 1$

  ➤ $h(20_{10}) = 10100_2$

  ➤ $h(8_{10}) = 1000_2$

  ➤ $h(24_{10}) = 11000_2$

  ➤ $h(32_{10}) = 100000_2$

➤ Next, we insert records with keys 10 (into the page 11) and 5 (into the page 01)

  ➤ $h(10_{10}) = 1010_2$

  ➤ $h(5_{10}) = 101_2$

➤ Having inserted additional 2 records, we split the page 01 into pages $p_0 = 001$, $p_1 = 101$, redistribute the record 5 from page 01, and we set $p = 2$

000	001	10	11	100	101
8		10	11	20	5
24			3		
32			27		

19

➤ Insert records with keys 37 into the structure from example 6 (see the picture)

  ➤ Stage $d = 1$

  ➤ Page capacity $b = 3$
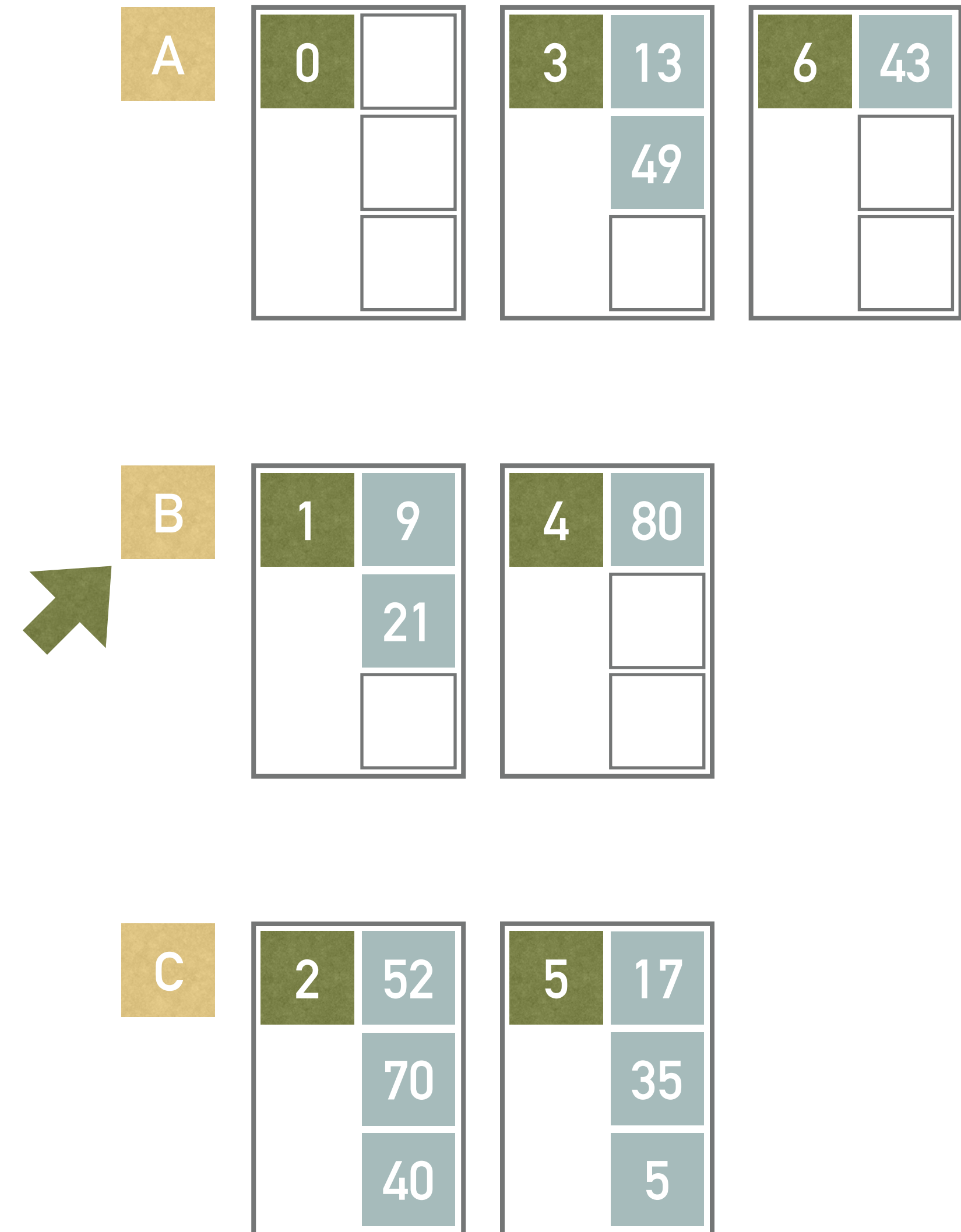
  ➤ Predefined condition $L = 2$

  ➤ Hash functions:

    ➤ $h_0(k) = k \mod 4$

    ➤ $h_1(k) = k \mod 3$

    ➤ $h_2(k) = (k \div 3) \mod 3$

➤ Note all the computations and illustrate the solution

A

0	

3	13
	49

6	43

B

1	9
	21

4	80

C

2	52
	70
	40

5	17
	35
	5

EXERCISE 3: SOLUTION

➤ The hash function $h_0(37) = 37 \mod 4 = 1$ sends the record with key 37 into page 1

➤ That has already been split, therefore the h_1 must be used

➤ $h_1(37) = 37 \mod 3 = 1$ sends the key 37 into page 3, but this page has already been split in this stage as well

➤ Therefore, $h_2(37) = (37 \div 3) \mod 3 = 0$ sends the record to the page 0

A	0	37		3	13		6	43
					49			

B	1	9		4	80
		21			

C	2	52		5	17
		70			35
		40			5