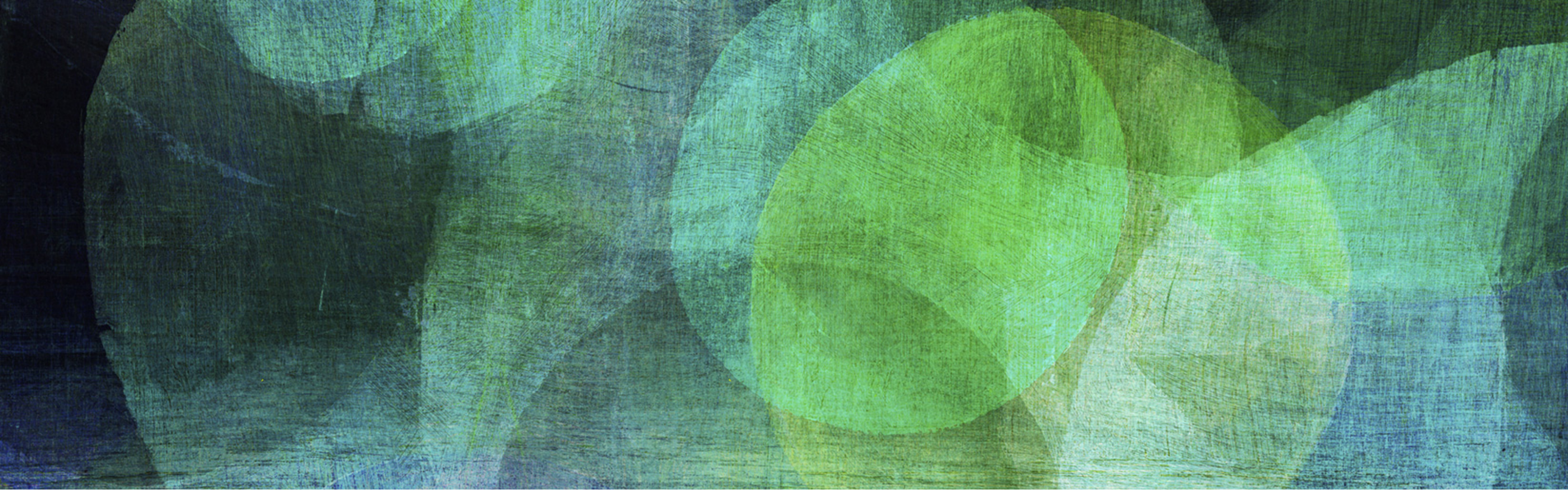
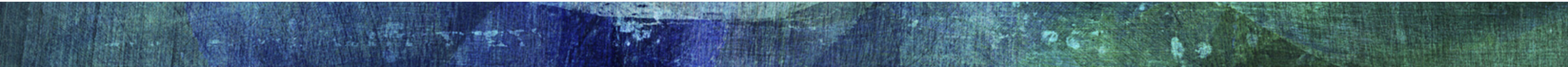


STATIC HASHING: SOLUTION

NDBI007: Practical Class 3



EXERCISE 1

- Expand directory from example 2
  - Insert record 28
  - Primary hashing function is given as $h(k, s) = k \mod s$
  - Secondary hashing function is $h_i(k, r) = (k >> i) \mod r$
  - Compute all the parameters and illustrate the directory and primary file

EXERCISE 1: SOLUTION

- Select class storage
  - $h(28,7) = 28 \mod 7 = 0$

- We can expand the class storage at the end of the primary file, i.e., $p = 3$, $r = 3$

- Then we need to select proper i
  - $h_0(14,3) = (14 >> 0) \mod 3 = 14 \mod 3 = 2$
  - $h_0(21,3) = (21 >> 0) \mod 3 = 21 \mod 3 = 0$
  - $h_0(28,3) = (28 >> 0) \mod 3 = 28 \mod 3 = 1$

position	i	r	p
0	0	3	3
1			
2			
3	0	2	1
4			
5			
6			

key	value
0	14
1	10
2	17
3	21
4	28
5	14
6	
7	

EXERCISE 2

- Expand directory from exercise 1
  - Insert record 42
  - Primary hashing function is given as $h(k, s) = k \mod s$
  - Secondary hashing function is $h_i(k, r) = (k >> i) \mod r$
  - Compute all the parameters and illustrate the directory and primary file
  - Advice: If you get a collision for every i, increment parameter r by 1 and try computation again

EXERCISE 2: SOLUTION

- Select class storage
- $h(42,7) = 42 \mod 7 = 0$

- We can expand the class storage at the end of the primary file, i.e., $p = 3$, $r = 4$

- Then we need to select proper i
  - $(14 >> 0) \mod 4 = \mathbf{2}$ $(21 >> 0) \mod 4 = 1$ $(28 >> 0) \mod 4 = 0$ $(42 >> 0) \mod 4 = \mathbf{2}$
  - $(14 >> 1) \mod 4 = 3$ $(21 >> 1) \mod 4 = \mathbf{2}$ $(28 >> 1) \mod 4 = \mathbf{2}$ $(42 >> 1) \mod 4 = 1$
  - $(14 >> 2) \mod 4 = \mathbf{3}$ $(21 >> 2) \mod 4 = 1$ $(28 >> 2) \mod 4 = \mathbf{3}$ $(42 >> 2) \mod 4 = 2$
  - $(14 >> 3) \mod 4 = \mathbf{1}$ $(21 >> 3) \mod 4 = 2$ $(28 >> 3) \mod 4 = 3$ $(42 >> 3) \mod 4 = \mathbf{1}$
  - $(14 >> 4) \mod 4 = 0$ $(21 >> 4) \mod 4 = \mathbf{1}$ $(28 >> 4) \mod 4 = \mathbf{1}$ $(42 >> 4) \mod 4 = 2$
  - $(14 >> 5) \mod 4 = \mathbf{0}$ $(21 >> 5) \mod 4 = \mathbf{0}$ $(28 >> 5) \mod 4 = \mathbf{0}$ $(42 >> 5) \mod 4 = 1$
  - $(14 >> 6) \mod 4 = \mathbf{0}$ $(21 >> 6) \mod 4 = \mathbf{0}$ $(28 >> 6) \mod 4 = \mathbf{0}$ $(42 >> 6) \mod 4 = \mathbf{0}$

- For every $i > 5$ we always get a collision. In such case, we increase r by one
  - $(14 >> 0) \mod 5 = 4$ $(21 >> 0) \mod 5 = 1$ $(28 >> 0) \mod 5 = 3$ $(42 >> 0) \mod 5 = 2$

position	i	r	p
0	0	5	3
1			
2			
3	0	2	1
4			
5			
6			

key	value
0	14
1	10
2	17
3	
4	21
5	42
6	28
7	14
...	

EXERCISE 3

- Apply Larson & Kalja method to insert record 41 into the structure from example 4
  - Note all the computations and illustrate the result
  - Tip: In some cases, we can split multiple pages on a single insert

EXERCISE 3: SOLUTION

- $h_0(41) = 41 \mod 5 = 1$
  $s_0(41) = (41 >> 0) \mod 7 = 41 \mod 7 = 6 \sim 110_2$
- Page number 1 is full and the highest signature belongs to record 41
- Therefore, we upgrade separator to 110_2 and reinsert record 41
- $h_0(41) = 41 \mod 5 = 1$
  $s_0(41) = (41 >> 0) \mod 7 = 41 \mod 7 = 6 \sim 110_2$
- Again, page number 1 but this time 41 has too big signature, so we fail to insert (i is increased) and we try to insert 41 again
- $h_1(41) = (41 + 1) \mod 5 = 2 \quad s_1(41) = (41 >> 1) \mod 7 = 6 \sim 110_2$
- Page number 2 is also full and again 41 has the biggest signature
- We update page separator and reinsert again
- $h_2(41) = (41 + 2) \mod 5 = 3 \quad s_2(41) = (41 >> 2) \mod 7 = 3 \sim 011_2$

0	10	40	30
110	011	101	010
1	51	61	20
110	010	101	011
2	32	37	42
111	100	010	000
3	41		
111	011		
4			
111			

EXERCISE 4

- Apply Larson & Kalja method to insert record 67 into the structure from exercise 3
  - Note all the computations and illustrate the result
  - Tip: If one page contains more records with the same signature and we need to split this page, then we may reinsert more than just a single record

EXERCISE 4: SOLUTION

- $h_0(67) = 67 \mod 5 = 2$
  $s_0(67) = (67 >> 0) \mod 7 = 67 \mod 7 = 4 \sim 100_2$
- We try to insert record 67 into page 2
- The page 2 is full, therefore we have to split the page
- This time, we have two values, i.e., 32 and 67, with the biggest signature
- So we update the page separator and reinsert both values
- $h_1(32) = (32 + 1) \mod 5 = 3$
  $s_1(32) = (32 >> 1) \mod 7 = 5 \sim 101_2$
- $h_1(67) = (67 + 1) \mod 5 = 3$
  $s_1(67) = (67 >> 1) \mod 7 = 2 \sim 010_2$

0	10	40	30
110	011	101	010
1	51	61	20
110	010	101	011
2		37	42
100		010	000
3	41	32	67
111	011	101	10
4			
111			