

8.3 Radix Sort

Example :

↓	↓	↓	
423	430	423	183
537	192	727	192
727	⇒ 423	⇒ 430	⇒ 423
430	183	537	430
192	537	183	537
183	727	192	727

Let A be an array of length n where every entry in A is a d -digit number. Say the digits range from 0 to k .

|| Radix-Sort(A, d)
 for $i = 1$ to d
 use a stable sort on A digit i 's.

Running time of Radix-Sort :

Say we use counting sort for each digit

counting-sort is $\Theta(n+k)$

repeat d times

\therefore Running-time of Radix-Sort is
 $\Theta(d(n+k))$

If $k = O(n)$ then Radix-sort
has running time $\Theta(d(n+n)) = \Theta(n)$

10 columns : $d = 10$

Example :

10 columns : $d = 10$

1	0	0	1	1	0	0	1	0	1
1	1	0	1	0	1	1	0	0	0
0	1	0	1	0	1	1	1	0	1
0	0	1	1	1	0	1	1	1	0
1	1	0	0	1	0	1	0	1	0
⋮									

$d = 10$
 $k = 1$ } Radix-Sort is $\Theta(10(n+1))$

$$\left. \begin{array}{l} d = 5 \\ k = 3 \end{array} \right\} \text{Radix-Sort is } \Theta(5(n+3))$$

$$\left. \begin{array}{l} d = 4 \\ k = 7 \end{array} \right\} \text{Radix-Sort is } \Theta(4(n+7))$$

⋮

$$\left. \begin{array}{l} d = 2 \\ k = 2^5 - 1 = 31 \end{array} \right\} \text{Radix Sort is } \Theta(2(n+31))$$

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$$\left. \begin{array}{l} d = 1 \\ k = 2^{10} - 1 = 1023 \end{array} \right\} \text{Radix Sort is } \Theta(n+1023)$$

Given array as follows:

b bits

n {

1	0	1	1	0	1	-	-	-	1	0	1
1	1	0	1	0	0	-	-	-	0	0	1
0	1	0	1	1	0	-	-	-	1	1	0
:	:	:	:	:	:	:	:	:	:	:	:
1	:	:	:	:	:	:	:	:	:	:	:
1	0	1	1	1	1	-	-	-	0	0	1

say $1 \leq r \leq b$

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Range of values is $2^r - 1$

Number of columns is $\lceil \frac{b}{r} \rceil$

Then Radix-Sort is $\Theta(\lceil \frac{b}{r} \rceil (n + 2^r - 1))$

what is the optimal value for r ?

To balance the terms,
the best choice is $r \approx \log n$.