

# Radix Sort

<https://visualgo.net/bn/sorting>

# Bucket Sort

- Given that, we have  $N$  integers in the range 0 to  $M-1$
- Maintain an array count of size  $M$ , which is initialized to zero. Thus, count has  $M$  cells (buckets).
  - [Pass 1](#)
  - [Pass 2](#)
  - [Pass 3](#)
- Read  $A_i$
- Increment  $\text{count}[A_i]$  by 1
- After all the input array is read, scan the count array, printing out a representation of sorted list.

# Radix Sort

- Radix sort is generalization of bucket sort.
- It uses several passes of bucket sort
- Perform the bucket sorts by “least significant digits”
  - First sort by digit in units place
  - Second sort by digit in tens place
  - Third sort by digit in hundreds place
  - .....

Pass 1

Pass 2

Pass 3

Let's sort the following array using radix sort:

Pass 1

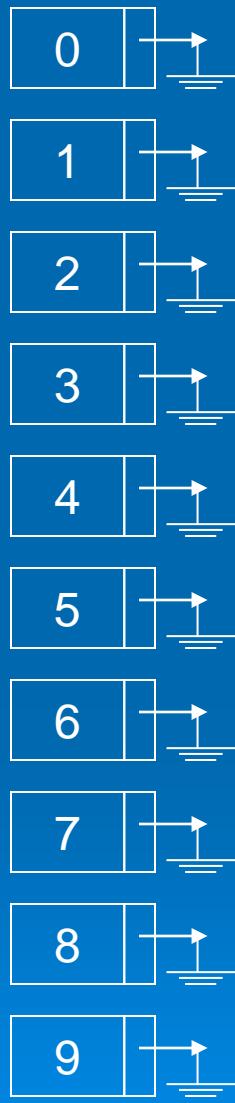
Pass 2

Pass 3

64		8		216		512		27		729		0		1		343		125
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# Pass 1

Pass 1  
Pass 2  
Pass 3



Pass 1  
Pass 2  
Pass 3

64	8	216	512	27	729	0	1	343	125
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Pass 1

Pass 2

Pass 3

64	8	216	512	27	729	0	1	343	125
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Pass 1

Pass 2

Pass 3

64	8	216	512	27	729	0	1	343	125
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Pass 1

Pass 2

Pass 3

64	8	216	512	27	729	0	1	343	125
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Pass 1

Pass 2

Pass 3

64	8	216	512	27	729	0	1	343	125
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Pass 1

Pass 2

Pass 3

64	8	216	512	27	729	0	1	343	125
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Pass 1

Pass 2

Pass 3

64	8	216	512	27	729	0	1	343	125
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Pass 1

Pass 2

Pass 3



64	8	216	512	27	729	0	1	343	125
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Pass 1

Pass 2

Pass 3

64	8	216	512	27	729	0	1	343	125
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Pass 1

Pass 2

Pass 3

64	8	216	512	27	729	0	1	343	125
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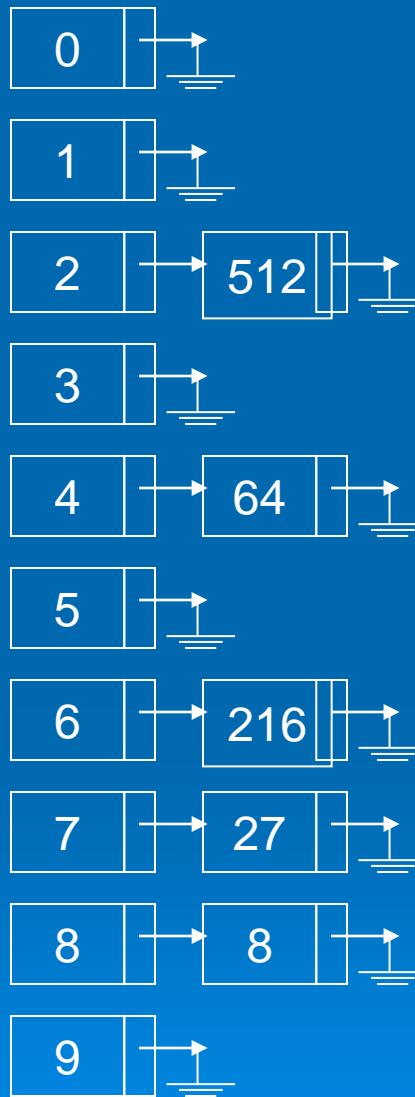


Pass 1

Pass 2

Pass 3

64	8	216	512	27	729	0	1	343	125
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Pass 1  
Pass 2  
Pass 3

64	8	216	512	27	729	0	1	343	125
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Pass 1

Pass 2

Pass 3

64	8	216	512	27	729	0	1	343	125
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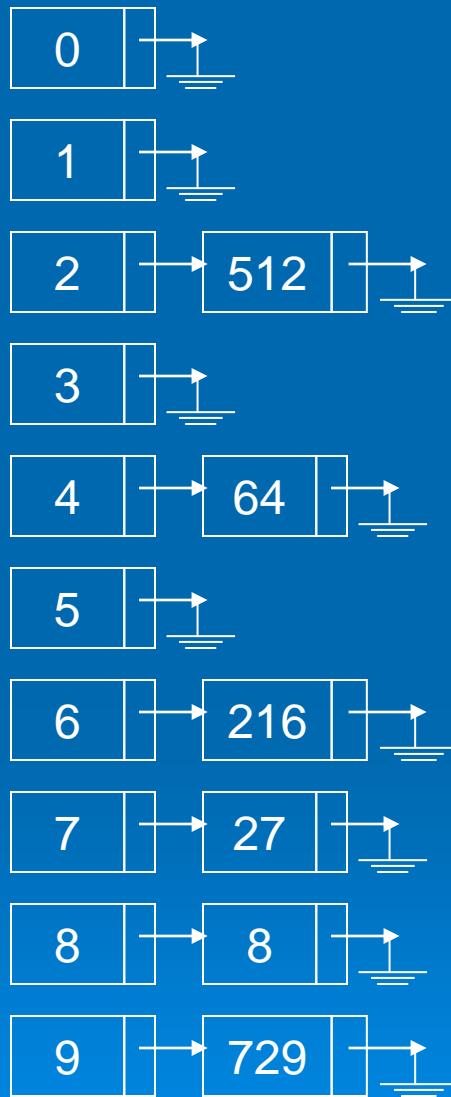
Pass 1

Pass 2

Pass 3



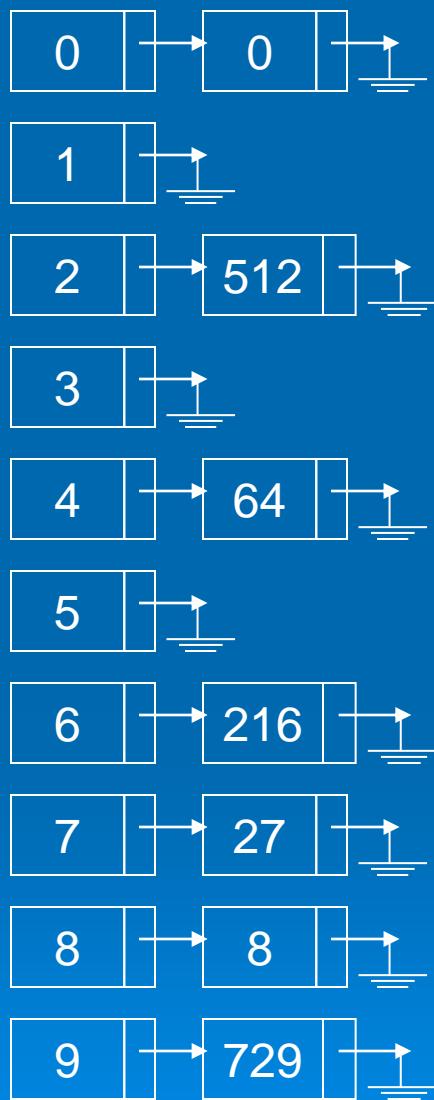
64	8	216	512	27	729	0	1	343	125
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Pass 1  
Pass 2  
Pass 3



64	8	216	512	27	729	0	1	343	125
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Pass 1  
Pass 2  
Pass 3



64	8	216	512	27	729	0	1	343	125
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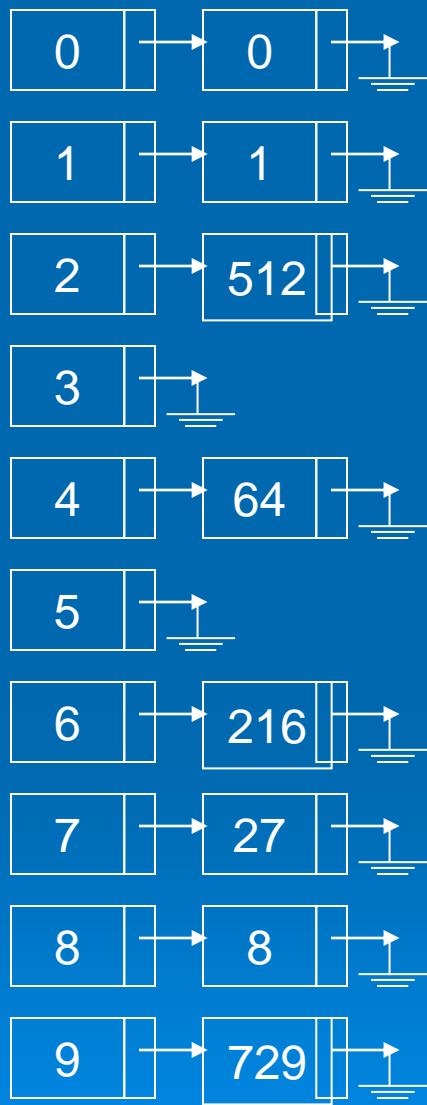


Pass 1

Pass 2

Pass 3

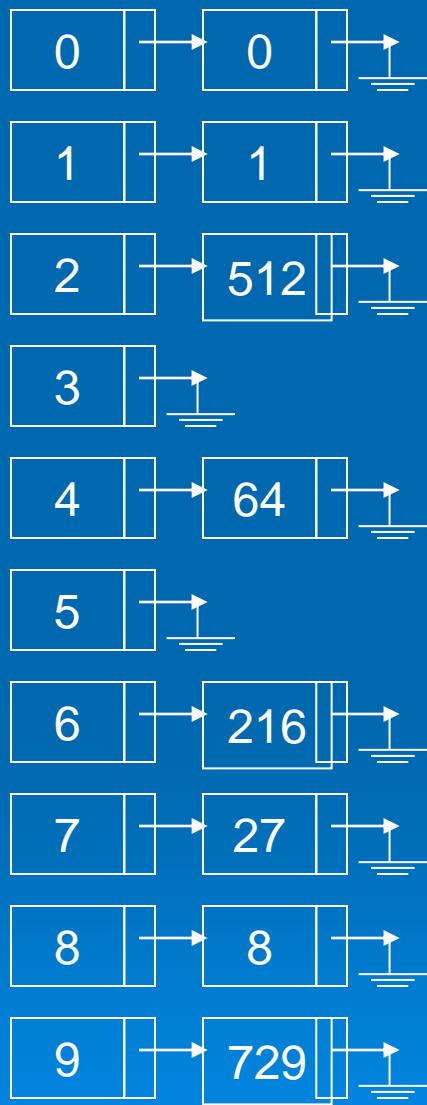
64	8	216	512	27	729	0	1	343	125
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Pass 1  
Pass 2  
Pass 3



64	8	216	512	27	729	0	1	<b>343</b>	125
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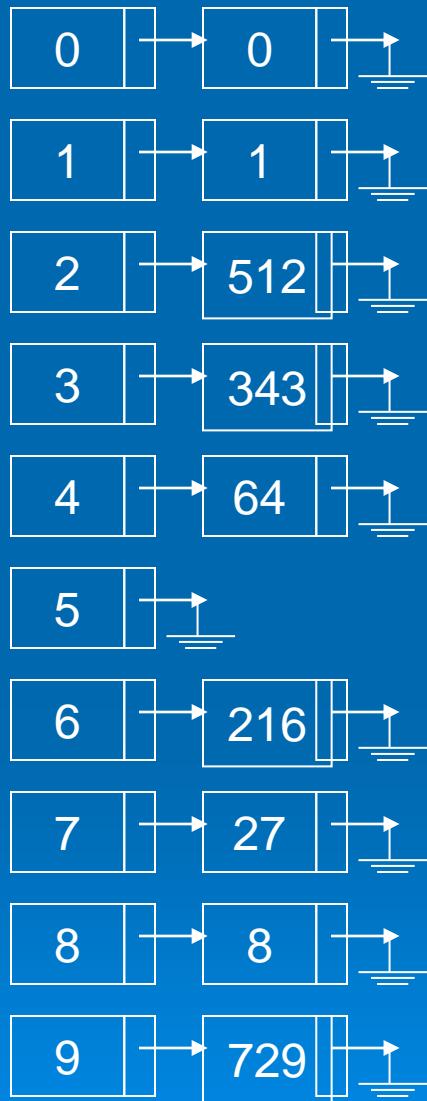


Pass 1

Pass 2

Pass 3

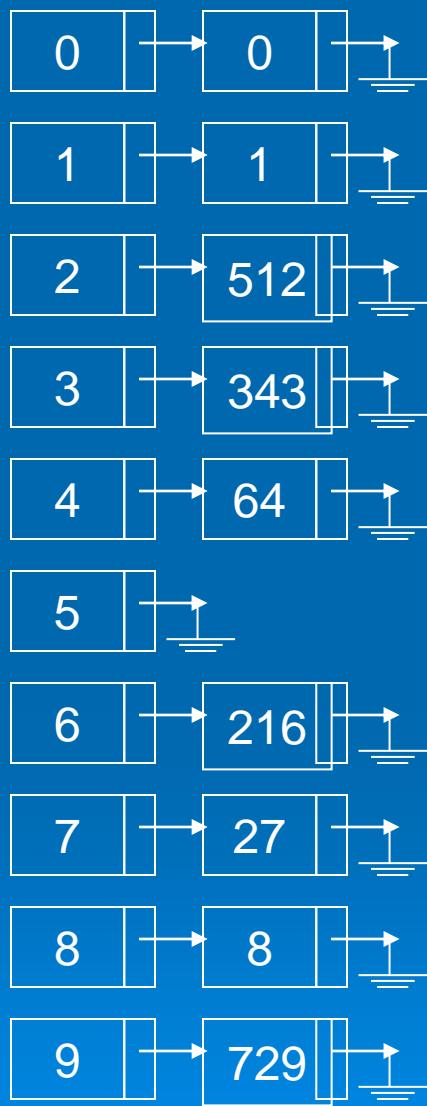
64	8	216	512	27	729	0	1	343	125
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Pass 1  
Pass 2  
Pass 3

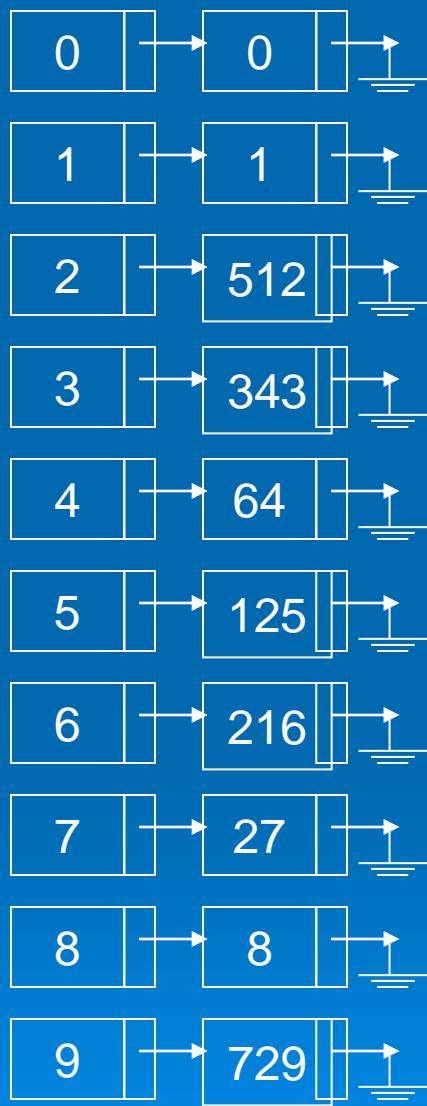


64	8	216	512	27	729	0	1	343	125
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Pass 1  
Pass 2  
Pass 3

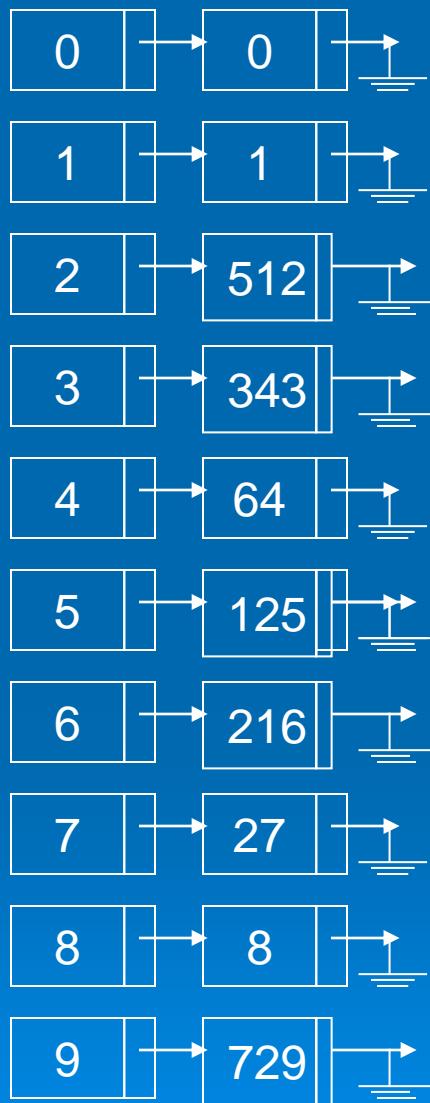
64	8	216	512	27	729	0	1	343	125
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Pass 1  
Pass 2  
Pass 3

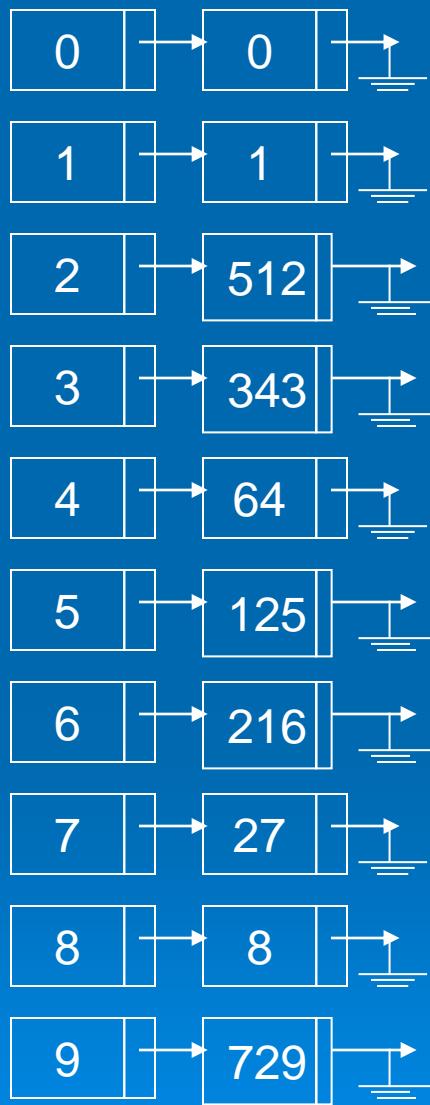


64	8	216	512	27	729	0	1	343	125
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Pass 1  
Pass 2  
Pass 3

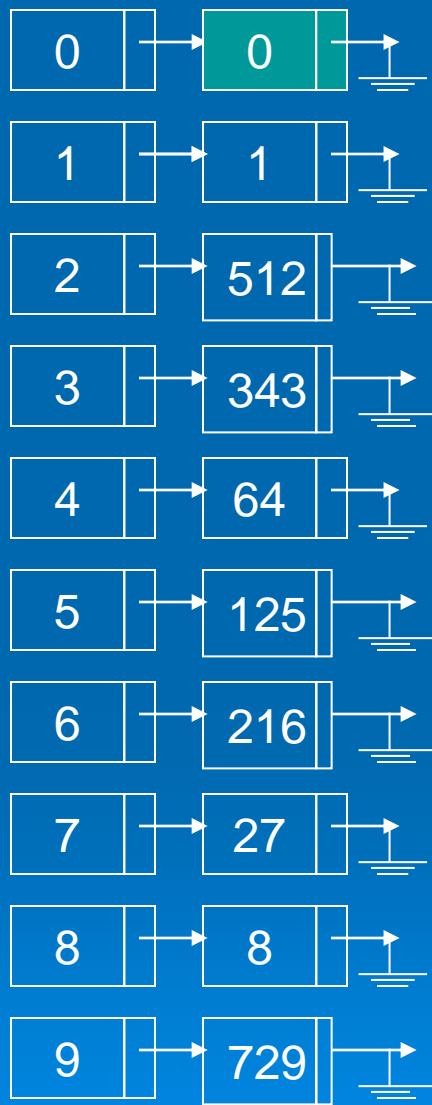




Pass 1

Pass 2

Pass 3

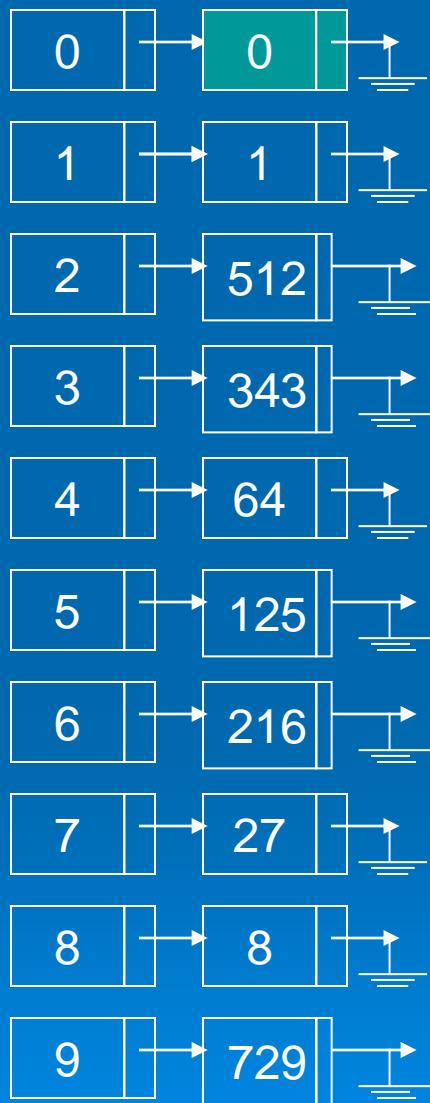


Pass 1

Pass 2

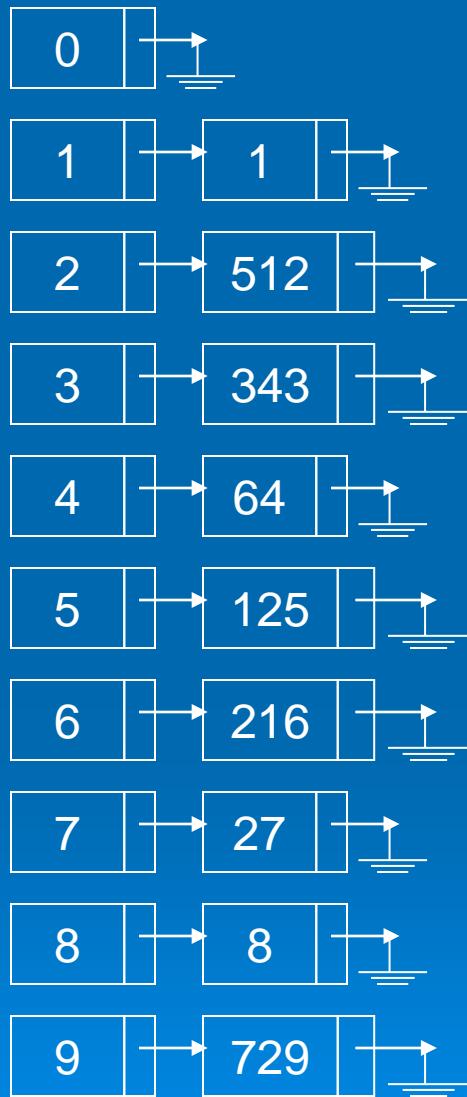
Pass 3

0								
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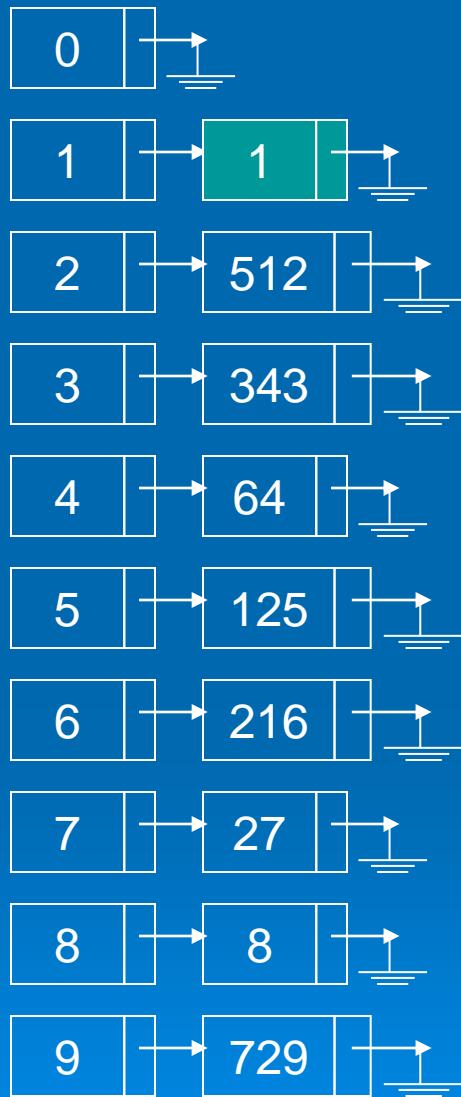
Pass 1  
Pass 2  
Pass 3

0									
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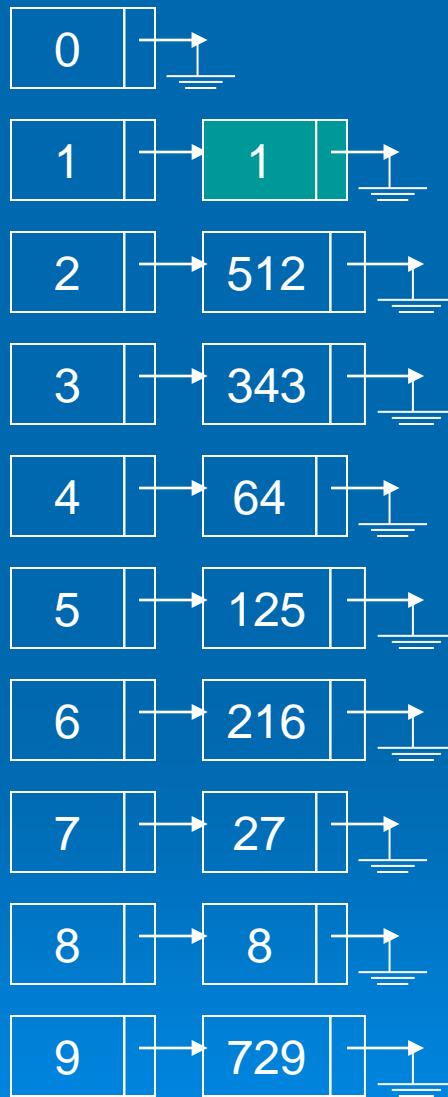
Pass 1  
Pass 2  
Pass 3

0								
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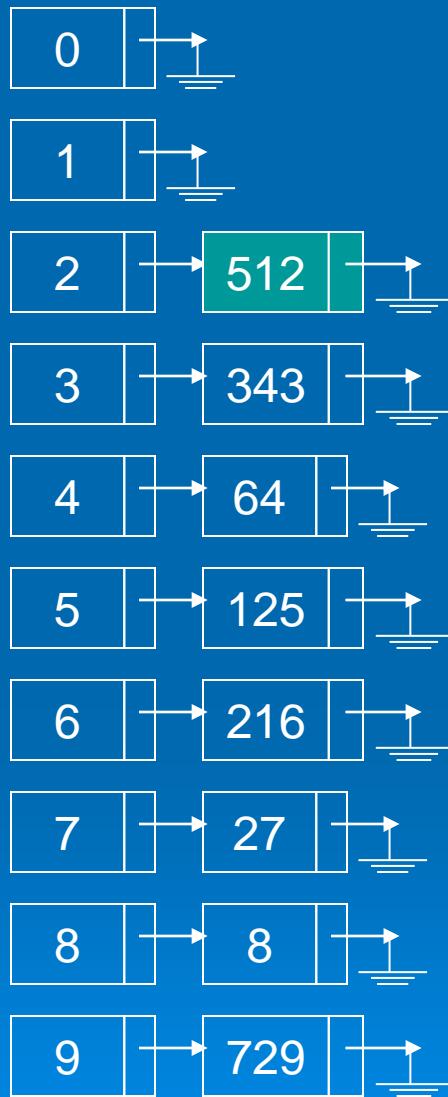
Pass 1  
Pass 2  
Pass 3

0	1							
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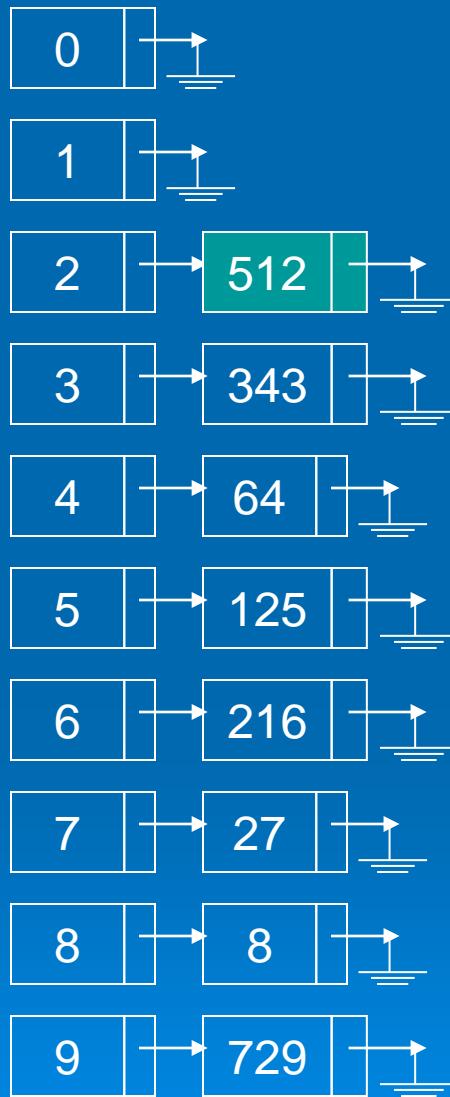
Pass 1  
Pass 2  
Pass 3

0	1							
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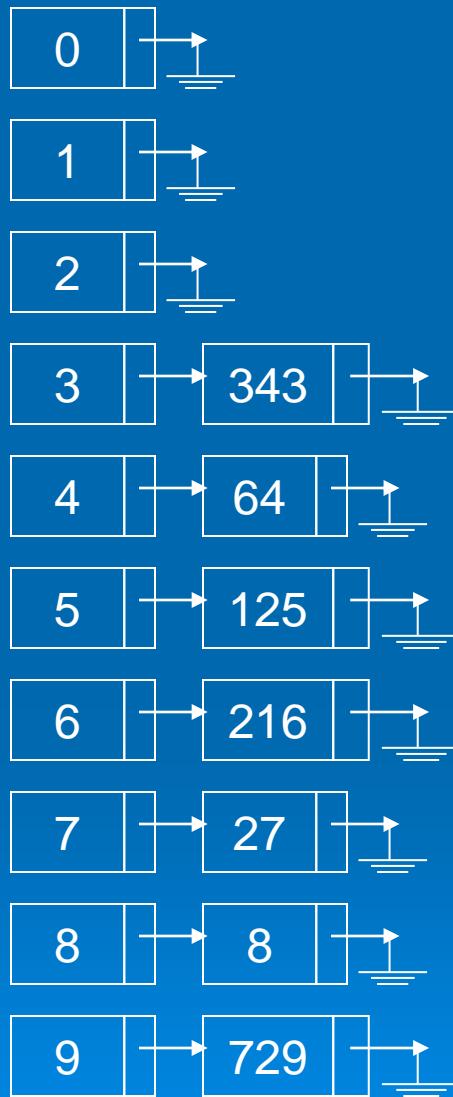
Pass 1  
Pass 2  
Pass 3

0	1	512						
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Pass 1  
Pass 2  
Pass 3

0	1	512						
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Pass 1  
Pass 2  
Pass 3

# Pass 2

Pass 1  
Pass 2  
Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

00	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3



0	01	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1

Pass 2

Pass 3



0	1	512	343	64	125	216	27	8	729
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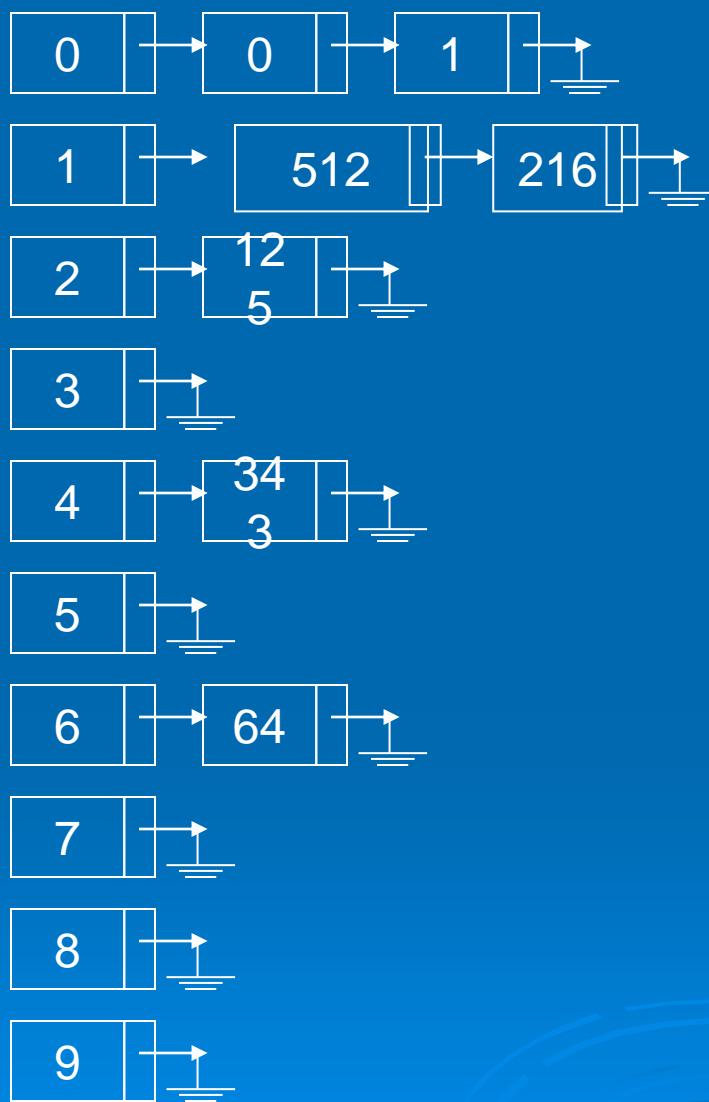


Pass 1

Pass 2

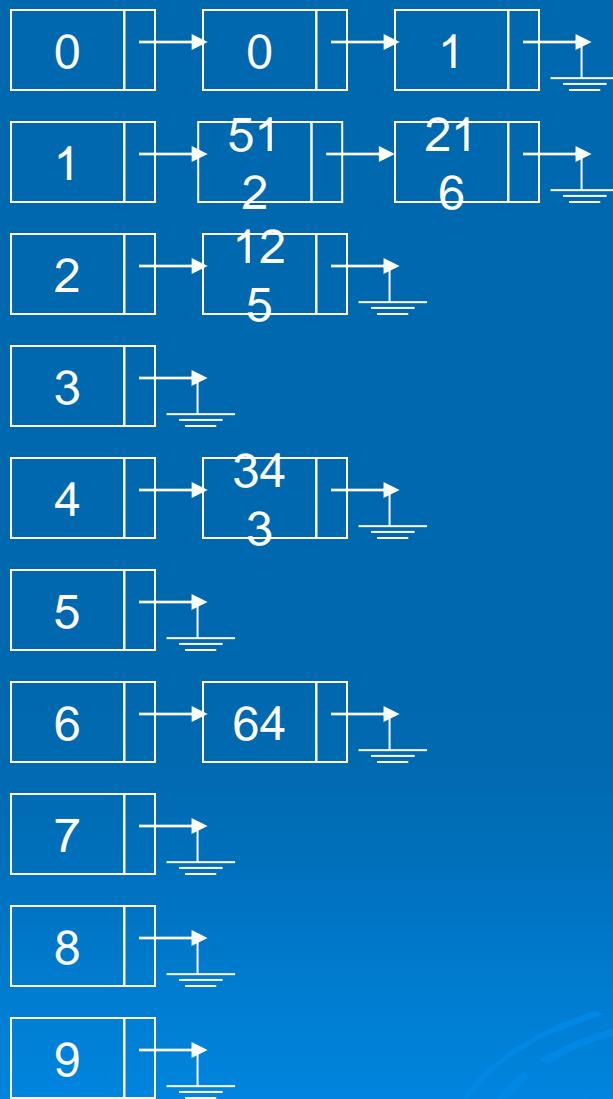
Pass 3

0	1	512	343	64	125	216	27	8	729
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Pass 1  
Pass 2  
Pass 3

0	1	51 2	34 3	64	12 5	21 6	<b>27</b>	8	72 9
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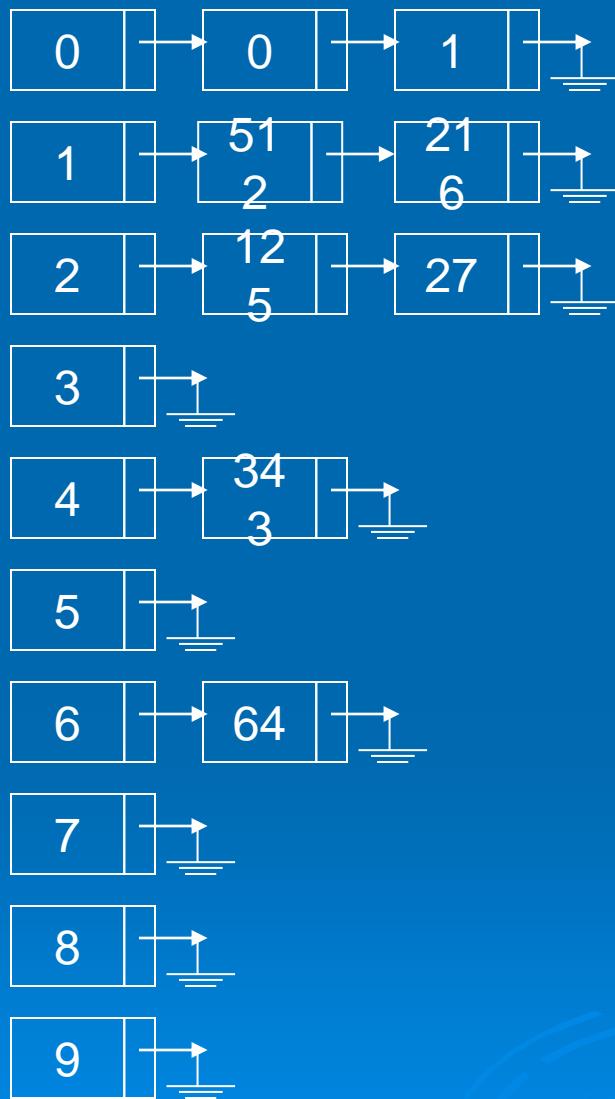


Pass 1

Pass 2

Pass 3

0	1	51 2	34 3	64	12 5	21 6	27	8	72 9
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Pass 1

Pass 2

Pass 3

0	1	51 2	34 3	64	12 5	21 6	27	08	72 9
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Pass 1



Pass 2



Pass 3



0	1	51 2	34 3	64	12 5	21 6	27	8	72 9
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Pass 1

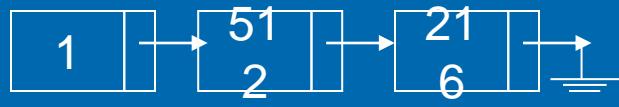
Pass 2

Pass 3

0	1	51 2	34 3	64	12 5	21 6	27	8	72 9
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Pass 1



Pass 2



Pass 3



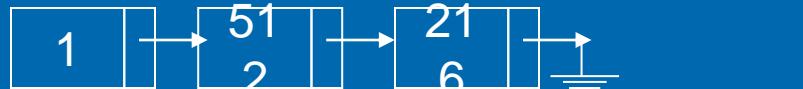
0	1	51 2	34 3	64	12 5	21 6	27	8	72 9
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Pass 1

Pass 2

Pass 3



0	1	51 2	34 3	64	12 5	21 6	27	8	72 9
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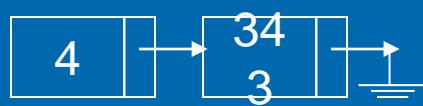
Pass 1

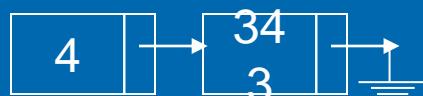
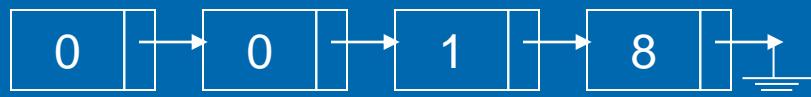


Pass 2



Pass 3



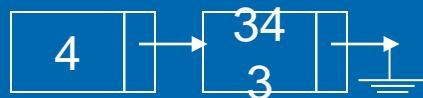


Pass 1

Pass 2

Pass 3

0	1	8						
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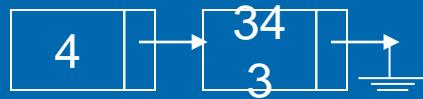
Pass 1

Pass 2

Pass 3



0	1	8						
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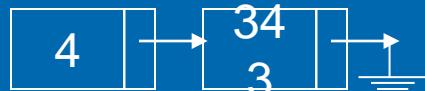


Pass 1

Pass 2

Pass 3

0	1	8	51	21				
2		6	2	51	21			



Pass 1

Pass 2

Pass 3



0	1	8	51	21				
2			2	6				

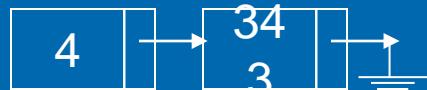


Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72		
2	6	5	2	6	5	27	9	9	

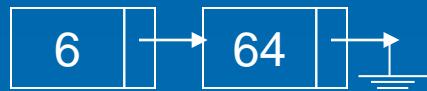
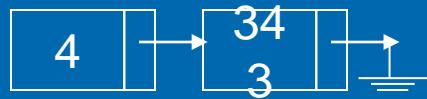


Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72		
2	6	5	27	9					

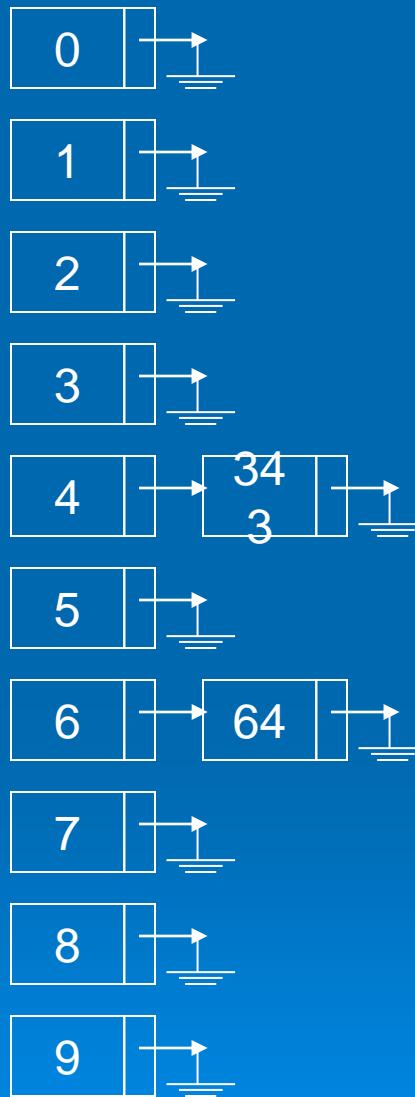


Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	
2	6	5	27	9	3				



Pass 1  
Pass 2  
Pass 3

0	1	8	51	21	12	27	72	34	
2	6	5	27	9	3				



Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	64
2	6	5	27	9	3				



Pass 1

Pass 2

Pass 3

# Pass 3

Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	64
2	6	5	27	9	3	64	34	21	12



Pass 1

Pass 2

Pass 3

<b>00</b>	1	8	51	21	12	27	72	34	64
0	2	6	2	6	5	9	3		



Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	64
2	6	5	27	9	3				



Pass 1

Pass 2

Pass 3

0	00	8	51	21	12	27	72	34	64
1	1								



Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	64
2	6	5	27	9	3				



Pass 1

Pass 2

Pass 3

0	1	00	51	21	12	27	72	34	64
8	2	6	5	9	3				



Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	64
2	6	5	27	9	3				



Pass 1

Pass 2

Pass 3

0	1	8	<b>51</b>	21	12	27	72	34	64
2	6	5	9	3					



Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	64
2	6	5	9	3					



Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	64
2	6	5	9	3					

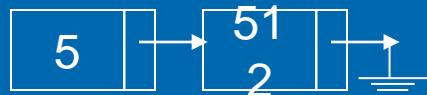


Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	64
2	6	5	9	3					



Pass 1

Pass 2

Pass 3

0	1	8	51 2	21 6	12 5	27	72 9	34 3	64
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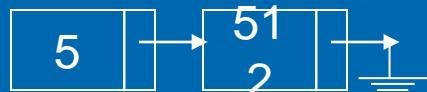
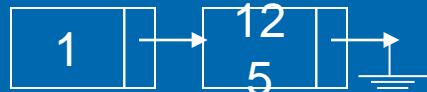


# Pass 1

## Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	64
2	6	5	12	5	12	5	9	3	

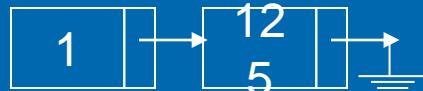


Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	<b>02</b>	72	34	64
2	6	5	6	5	5	7	9	3	

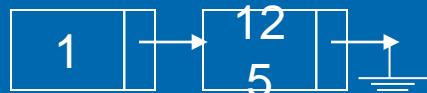


Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	<b>27</b>	72	34	64
2	6						9	3	

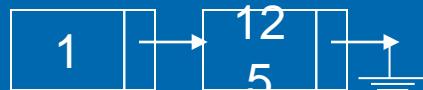


Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	<b>72</b>	34	64
2	6						9	3	

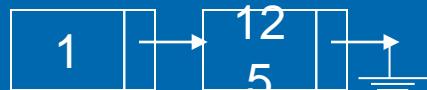


Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	<b>72</b>	34	64
2	6						9	3	



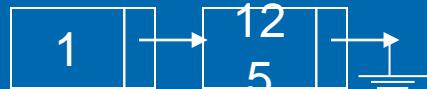
Pass 1

Pass 2

Pass 3



0	1	8	51	21	12	27	72	34	64
2	6	5	6	5	5	9	3	3	0

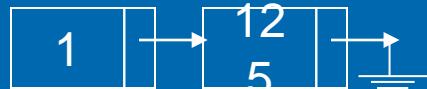


Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	64
2	6	5	6	5	5	9	3	3	

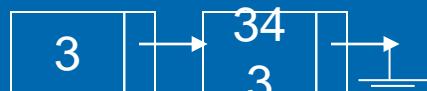
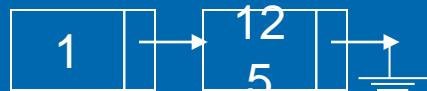


Pass 1

Pass 2

Pass 3

0	1	8	51	21	12	27	72	34	06
2	6	5	6	5	5	9	3	4	4



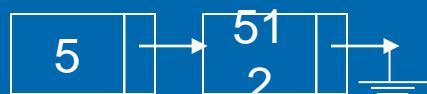
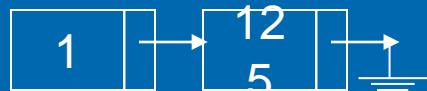
Pass 1

Pass 2

Pass 3



0	1	8	51	21	12	27	72	34	64
2	6	5	6	5	5	27	9	3	

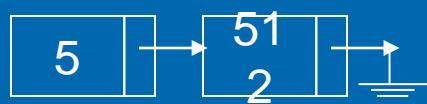
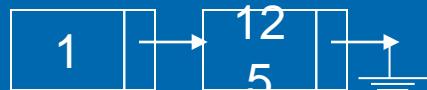


Pass 1

Pass 2

Pass 3

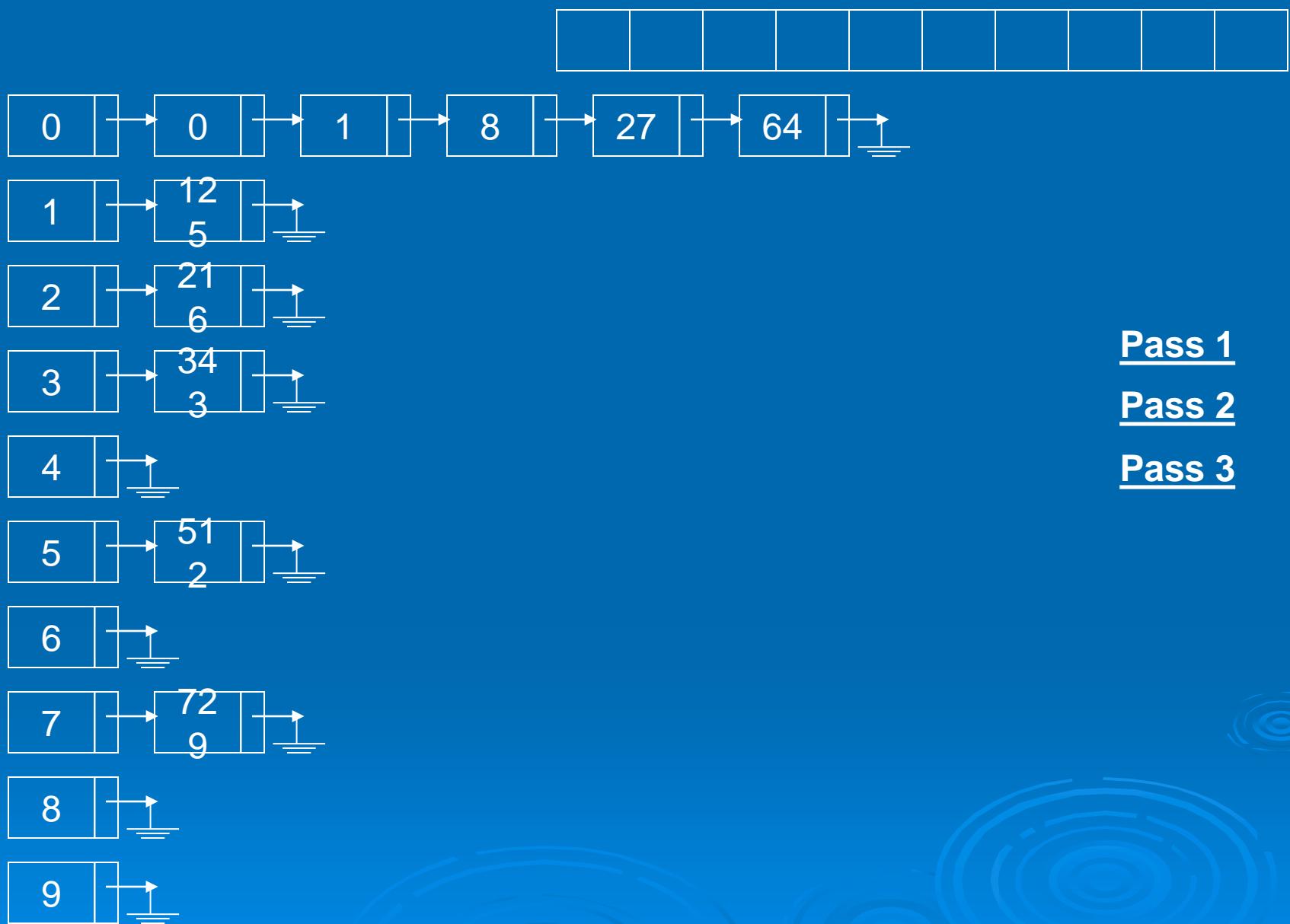
0	1	8	51	21	12	27	72	34	64
2	6	5	6	5	5	27	9	3	



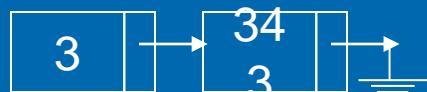
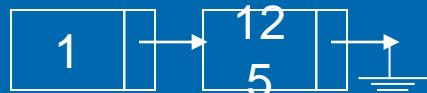
Pass 1

Pass 2

Pass 3



0	1	8	27	64				
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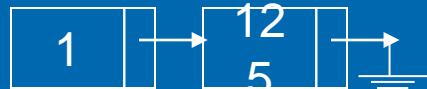


Pass 1

Pass 2

Pass 3

0	1	8	27	64				
---	---	---	----	----	--	--	--	--

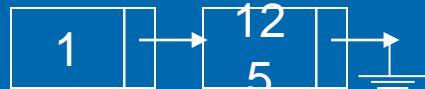


Pass 1

Pass 2

Pass 3

0	1	8	27	64	$\frac{12}{5}$			
---	---	---	----	----	----------------	--	--	--

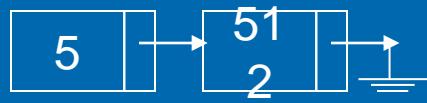
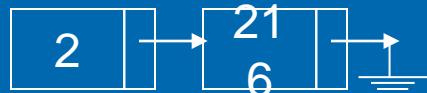


Pass 1

Pass 2

Pass 3

0	1	8	27	64	$\frac{12}{5}$			
---	---	---	----	----	----------------	--	--	--

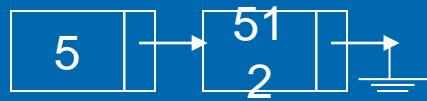
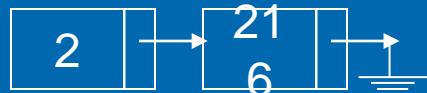


Pass 1

Pass 2

Pass 3

0	1	8	27	64	12	21		
					5	6		



Pass 1

Pass 2

Pass 3

0	1	8	27	64	12	21		
5		6						



Pass 1

Pass 2

Pass 3

0	1	8	27	64	12	21	34		
5	6	3							



Pass 1

Pass 2

Pass 3



0	1	8	27	64	12	21	34		
5	6	3							



Pass 1

Pass 2

Pass 3

0	1	8	27	64	12	21	34	51	
5	6	3	2						



Pass 1

Pass 2

Pass 3



0	1	8	27	64	12	21	34	51	
5	6	3	2						



Pass 1

Pass 2

Pass 3

0	1	8	27	64	12	21	34	51	72
5	6	3	6	3	2	9			



Pass 1

Pass 2

Pass 3



0	1	8	27	64	12	21	34	51	72
5	6	3	6	3	2	9			



Pass 1

Pass 2

Pass 3



```
radix_sort(int arr[], int n) {  
    int bucket[10][5],buck[10];  
    int i,j,k,l,num,div,large,passes;  
    div=1; num=0; large=arr[0];  
    for(i=0 ; i<n ; i++)  
        if(arr[i] > large)  
            large = arr[i];  
    while(large > 0) {  
        num++;  
        large = large/10;  
    }  
}
```

Pass 1  
Pass 2  
Pass 3

```
for(passes=0 ; passes<num ; passes++) {  
    for(k=0 ; k<10 ; k++) {  
        buck[k] = 0;  
    }  
    for(i=0 ; i<n ; i++) {  
        l = ((arr[i]/div)%10);  
        bucket[l][buck[l]++] = arr[i];  
    }  
    i=0;  
    for(k=0 ; k<10 ; k++) {  
        for(j=0 ; j<buck[k] ; j++) {  
            arr[i++] = bucket[k][j];  
        }  
    }  
    div*=10;  
}  
}
```

Pass 1

Pass 2

Pass 3



Pass 1  
Pass 2  
Pass 3

# The End