http://algs4.cs.princeton.edu

5.1 KEY-INDEXED COUNTING DEMO

Key-indexed counting demo

Goal. Sort an array `a[]` of N integers between 0 and $R - 1$.

- Count frequencies of each letter using key as index.
- Compute frequency cumulates which specify destinations.
- Access cumulates using key as index to move items.
- Copy back into original array.

```
int N = a.length;
int[] count = new int[R+1];

for (int i = 0; i < N; i++)
   count[a[i]+1]++;

for (int r = 0; r < R; r++)
   count[r+1] += count[r];

for (int i = 0; i < N; i++)
   aux[count[a[i]]++] = a[i];

for (int i = 0; i < N; i++)
   a[i] = aux[i];
```

R = 6

i	a[i]
0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

use a for 0
b for 1
c for 2
d for 3
e for 4
f for 5

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for (int r = 0; r < R; r++)
   count[r+1] += count[r];

for (int i = 0; i < N; i++)
   aux[count[a[i]]++] = a[i];

for (int i = 0; i < N; i++)
   a[i] = aux[i];
```

count frequencies

i	a[i]
0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

offset by 1
[stay tuned]

r	count[r]
a	0
b	2
c	3
d	1
e	2
f	1
-	3

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for (int i = 0; i < N; i++)
   aux[count[a[i]]++] = a[i];

for (int i = 0; i < N; i++)
   a[i] = aux[i];
```
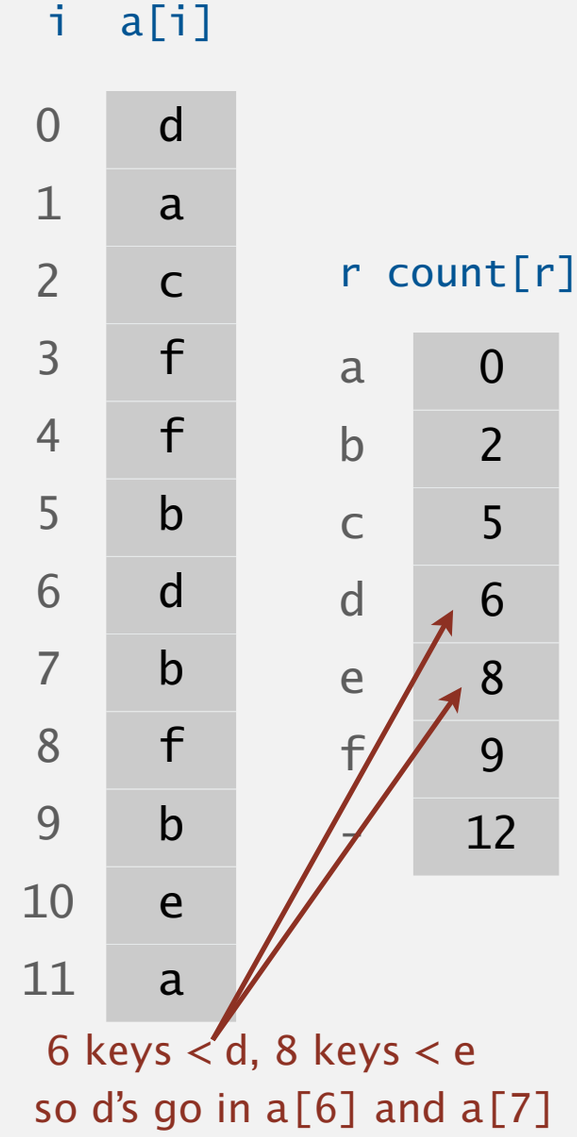

compute cumulates



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int N = a.length;
int[] count = new int[R+1];

for (int i = 0; i < N; i++)
   count[a[i]+1]++;

for (int r = 0; r < R; r++)
   count[r+1] += count[r];

for (int i = 0; i < N; i++)
   aux[count[a[i]]++] = a[i];

for (int i = 0; i < N; i++)
   a[i] = aux[i];
```

move items

i	a[i]
0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	0
b	2
c	5
d	6
e	8
f	9
-	12

i	aux[i]
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	

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move items

i	a[i]
0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	0
b	2
c	5
d	7
e	8
f	9
-	12

i	aux[i]
0	
1	
2	
3	
4	
5	
6	d
7	
8	
9	
10	
11	

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for (int i = 0; i < N; i++)
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```

move items

i	a[i]
0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	1
b	2
c	5
d	7
e	8
f	9
-	12

i	aux[i]
0	a
1	
2	
3	
4	
5	
6	d
7	
8	
9	
10	
11	

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move items

i	a[i]
0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	1
b	2
c	6
d	7
e	8
f	9
-	12

i	aux[i]
0	a
1	
2	
3	
4	
5	c
6	d
7	
8	
9	
10	
11	

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move items

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0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	1
b	2
c	6
d	7
e	8
f	10
-	12

i	aux[i]
0	a
1	
2	
3	
4	
5	c
6	d
7	
8	
9	f
10	
11	

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move items

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0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	1
b	2
c	6
d	7
e	8
f	11
-	12

i	aux[i]
0	a
1	
2	
3	
4	
5	c
6	d
7	
8	
9	f
10	f
11	

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move items

i	a[i]
0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	1
b	3
c	6
d	7
e	8
f	11
-	12

i	aux[i]
0	a
1	
2	b
3	
4	
5	c
6	d
7	
8	
9	f
10	f
11	

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move items

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0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	1
b	3
c	6
d	8
e	8
f	11
-	12

i	aux[i]
0	a
1	
2	b
3	
4	
5	c
6	d
7	d
8	
9	f
10	f
11	

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move items

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0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	1
b	4
c	6
d	8
e	8
f	11
-	12

i	aux[i]
0	a
1	
2	b
3	b
4	
5	c
6	d
7	d
8	
9	f
10	f
11	

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move items

i	a[i]
0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	1
b	4
c	6
d	8
e	8
f	12
-	12

i	aux[i]
0	a
1	
2	b
3	b
4	
5	c
6	d
7	d
8	
9	f
10	f
11	f

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move items

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0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	1
b	5
c	6
d	8
e	8
f	12
-	12

i	aux[i]
0	a
1	
2	b
3	b
4	b
5	c
6	d
7	d
8	
9	f
10	f
11	f

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move items

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0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	1
b	5
c	6
d	8
e	9
f	12
-	12

i	aux[i]
0	a
1	
2	b
3	b
4	b
5	c
6	d
7	d
8	e
9	f
10	f
11	f

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for (int i = 0; i < N; i++)
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move items

i	a[i]
0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	2
b	5
c	6
d	8
e	9
f	12
-	12

i	aux[i]
0	a
1	a
2	b
3	b
4	b
5	c
6	d
7	d
8	e
9	f
10	f
11	f

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   aux[count[a[i]]++] = a[i];

for (int i = 0; i < N; i++)
   a[i] = aux[i];
```

move items

i	a[i]
0	d
1	a
2	c
3	f
4	f
5	b
6	d
7	b
8	f
9	b
10	e
11	a

r	count[r]
a	2
b	5
c	6
d	8
e	9
f	12
-	12

i	aux[i]
0	a
1	a
2	b
3	b
4	b
5	c
6	d
7	d
8	e
9	f
10	f
11	f

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for (int i = 0; i < N; i++)
   aux[count[a[i]]++] = a[i];

for (int i = 0; i < N; i++)
   a[i] = aux[i];
```

copy back

i	a[i]
0	a
1	a
2	b
3	b
4	b
5	c
6	d
7	d
8	e
9	f
10	f
11	f

r	count[r]
a	2
b	5
c	6
d	8
e	9
f	12
-	12

i	aux[i]
0	a
1	a
2	b
3	b
4	b
5	c
6	d
7	d
8	e
9	f
10	f
11	f