

Insertion Sort.

Same as sorting a hand of playing cards.

INSERTION-SORT(A, n)

```
1 for  $i = 2$  to  $n$ 
2    $key = A[i]$ 
3   // Insert  $A[i]$  into the sorted subarray  $A[1 : i - 1]$ .
4    $j = i - 1$ 
5   while  $j > 0$  and  $A[j] > key$ 
6      $A[j + 1] = A[j]$ 
7      $j = j - 1$ 
8    $A[j + 1] = key$ 
```

$A = [A[1] \dots A[n]]$

\downarrow
 $A = [\dots \dots \dots]$

$j = i - 1$

draw 1.
card from deck

\downarrow
label it as 'key'
(index of 'key' = i)

check if the element to (left of 'key')
is larger than 'key'
($A[j] > key$)

yes

bad.

before re-checking

by $A[j+1] = A[j]$ (making space
for the key)

$j = j - 1$ (check the
left element
for next iter)

check if j cannot be moved
further left.

\Downarrow
key = smallest

no.

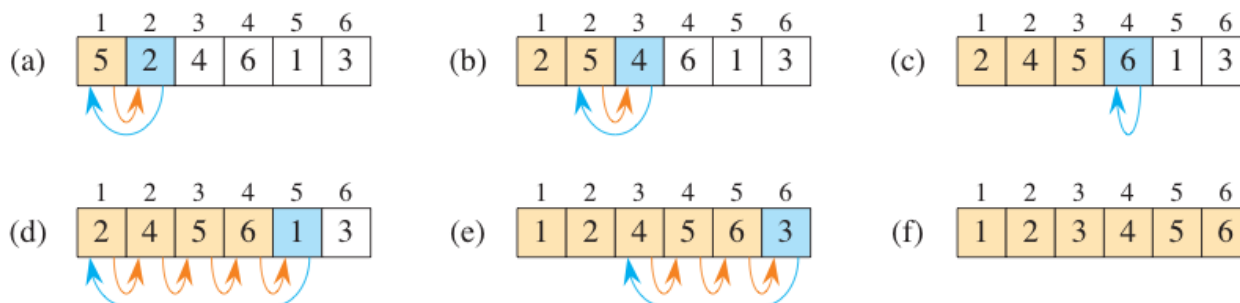
good!

$A[j] < key$.

put key on
the right
of $A[j]$

$A[j+1] = key$

Example



INSERTION-SORT(A, n)

$\langle 5, 2, 4, 6, 1, 3 \rangle$

Save the first 6 elem.
(all).

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```

(a) →

$i = 2$

↓ $A[i]$
[2]

key

$j = i - 1 = 1$

↓ $A[j]$
[5]

(to be compared)

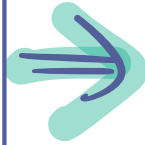


key 左 element

... → 说明 $A[j]$ 比 key 大.
不配在左!

move $A[j]$ to the right.

move j to the left $j = j - 1 = 0$.



Cannot move j to further left...

key is already smallest!



$A[j+1] = A[1] = \text{key}$.



(b)



$i = 3$



$A[i]$

4

key



$j = i - 1 = 2$

$A[j]$

5

(to be compared.)



key 小

不配

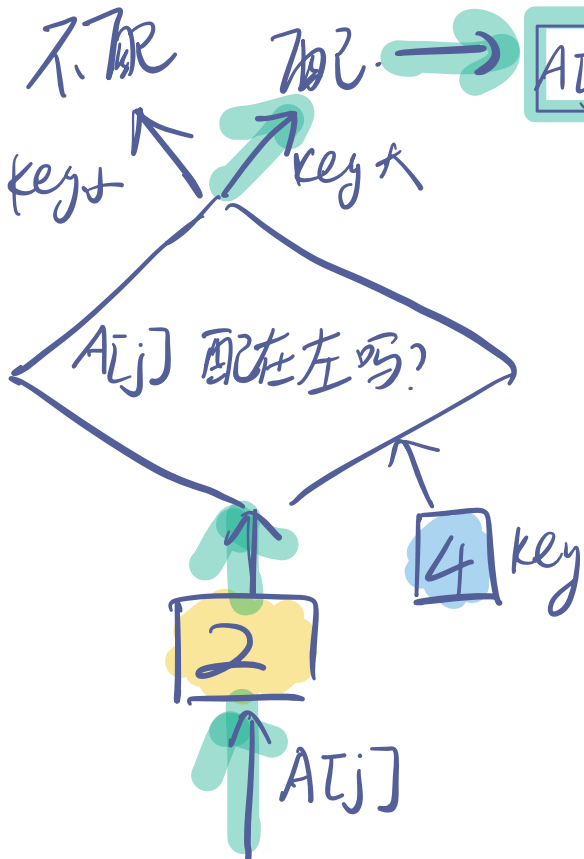
key 大

配

(c)



$A[j+1] = A[2] = \text{key}$.



move $A[j]$ to the right.

move j to the left $j = j - 1 = 1$.



小结:

Goal of insertion sort: [最小 ... 最大.]

(左 > 右) ← 用这个 check.

先选定一个 element (key) ← $A[i]$

再看它左边 ($A[j] = A[i-1]$)

再看左边的 配不配 在它 (key) 左边

