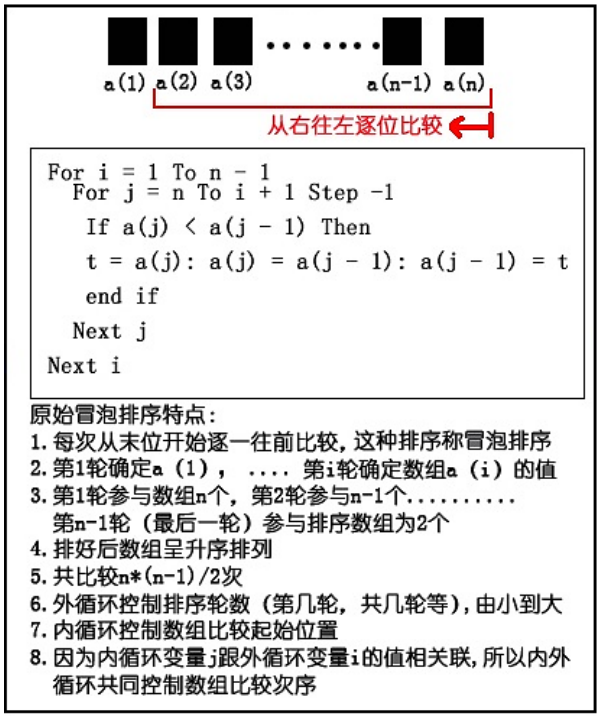
冒泡排序

基础知识




```
For i = 1 To n - 1
  For j = n To i + 1 Step -1
    If a(j) < a(j - 1) Then
    t = a(j): a(j) = a(j - 1): a(j - 1) = t
    end if
  Next j
Next i
```

原始冒泡排序特点：

1. 每次从末位开始逐一往前比较，这种排序称冒泡排序
2. 第1轮确定a（1），.... 第i轮确定数组a（i）的值
3. 第1轮参与数组n个，第2轮参与n-1个.....
   第n-1轮（最后一轮）参与排序数组为2个
4. 排好后数组呈升序排列
5. 共比较n*(n-1)/2次
6. 外循环控制排序轮数（第几轮，共几轮等），由小到大
7. 内循环控制数组比较起始位置
8. 因为内循环变量j跟外循环变量i的值相关联，所以内外循环共同控制数组比较次序

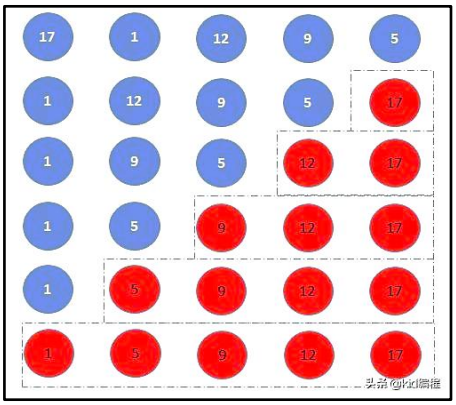


图 01 冒泡实例

改写

冒泡（升序排列）

```
For i = 1 To n - 1
    For j = n To i + 1 Step -1
        If a(j) < a(j - 1) Then
            t = a(j): a(j) = a(j - 1): a(j - 1) = t
        End If
    Next j
Next i
```

外循环 i=2 To n

```
For i = 2 To n
    For j = n To i Step -1
        If a(j) < a(j - 1) Then
            t = a(j): a(j) = a(j - 1): a(j - 1) = t
        End If
    Next j
Next i
```

改写:a(j-1)变为 a(j+1)

```
For i = 1 To n - 1
    For j = n - 1 To i Step -1
        If a(j) > a(j + 1) Then
            t = a(j): a(j) = a(j + 1): a(j + 1) = t
        End If
    Next j
Next i
```

降序排列

```
For i = 1 To n - 1
    For j = n To i + 1 Step -1
        If a(j) > a(j - 1) Then                    '只要将 a(j) < a(j - 1)换成 a(j) > a(j - 1)
            t = a(j): a(j) = a(j - 1): a(j - 1) = t
        End If
    Next j
Next i
```

外循环由大到小

```
For i = n - 1 To 1 Step -1
    For j = n To n - i + 1 Step -1
        If a(j) < a(j - 1) Then
            t = a(j): a(j) = a(j - 1): a(j - 1) = t
        End If
    Next j
Next i
```

内外循环都用 Do while 语循环改写

```
i = 1
Do while i <= n - 1
    j = n
    Do while j >= i + 1
        If a(j) < a(j - 1) Then
            t = a(j): a(j) = a(j - 1): a(j - 1) = t
        End If
        j = j - 1
    Loop
    i = i + 1
Loop
```

内循环变量由小到大-沉底排序(升序)

```
For i = 1 To n - 1
    For j = 1 To n - i                    '内循由小到大，即每次从第一个数组开始往后比较
        If a(j) > a(j + 1) Then                    '请注意语句与冒泡的区别化变
            t = a(j): a(j) = a(j + 1): a(j + 1) = t          '请注意语句与冒泡的区别化变
        End If
    Next j
Next i
```

优化

优化 1(已经有序)For

```
i = 1
For i = 1 To n - 1
    flag = False
    For j = n To i + 1 Step -1
        If a(j) < a(j - 1) Then
            t = a(j): a(j) = a(j - 1): a(j - 1) = t
            flag = True
        End If
    Next j
If flag = False Then Exit For
Next i
```

优化 1(已经有序)do

```
flag = True
i = 1:
Do while i <= n - 1 And flag = True
    flag = False
    For j = n To i + 1 Step -1
        If a(j) < a(j - 1) Then
            t = a(j): a(j) = a(j - 1): a(j - 1) = t
            flag = True
        End If
    Next j
    i = i + 1
Loop
```

优化 2(前面有序)

```
Last = 0
For i = 1 To n - 1
    For j = n To i + 1 Step -1
        If a(j) < a(j - 1) Then
            t = a(j): a(j) = a(j - 1): a(j - 1) = t
            Last = j
        End If
    Next j
    i = Last - 1
Next i
```

优化(外循环次数减少)改写简化

```
flag = True
lun = 0
Do while flag = True
    flag = False
    For j = n To 2 Step -1
        If a(j) < a(j - 1) Then
            t = a(j): a(j) = a(j - 1): a(j - 1) = t
            flag = True
        End If
    Next j
Loop
```

综合优化改写 do	综合优化 2-last

flag = True
i = 1
Do while i <= n - 1 And flag = True
flag = False
For j = n To i + 1 Step -1
If a(j) < a(j - 1) Then
t = a(j): a(j) = a(j - 1): a(j - 1) = t
i = j
flag = True
End If
Next j
Loop
	i = 1
	Last = 1: Last0 = 0
	Do while i <= n - 1 And Last0 <> Last
	' i <= n - 1 该条件可以省略，效果一样
	Last0 = Last
	i = Last
	For j = n To i + 1 Step -1
	If a(j) < a(j - 1) Then
	t = a(j): a(j) = a(j - 1): a(j - 1) = t
	Last = j
	End If
	Next j
	Loop

其他算法

奇偶位冒泡排序	奇偶位升降序不同分别排序

For i = 1 To (n - 1) \ 2
For j = n To i * 2 + 1 Step -1
If a(j) < a(j - 2) Then
t = a(j): a(j) = a(j - 2): a(j - 2) = t
End If
Next j
Next i
	For i = 1 To (n - 1) \ 2
	k = 1
	For j = n To i * 2 + 1 Step -1
	If a(j) * k < a(j - 2) * k Then
	t = a(j): a(j) = a(j - 2): a(j - 2) = t
	End If
	k = -k
	Next j
	Next i

去重复冒泡（末尾前移法）	**擂台排序(注意与选择排序的区别)**

bottom = n
For i = 1 To bottom - 1
For j = bottom To i + 1 Step -1
If a(j) < a(j - 1) Then
t = a(j): a(j) = a(j - 1): a(j - 1) = t
Elseif a(j) = a(j - 1) Then
a(j) = a(bottom)
bottom = bottom - 1
End If
Next j
Next i
	For i = 1 To n – 1
	'K = i
	For j = i + 1 To n
	If a(j) < a(i) Then
	t = a(j): a(j) = a(i): a(i) = t
	'i 可以用 k 来代替
	End If
	Next j
	Next i