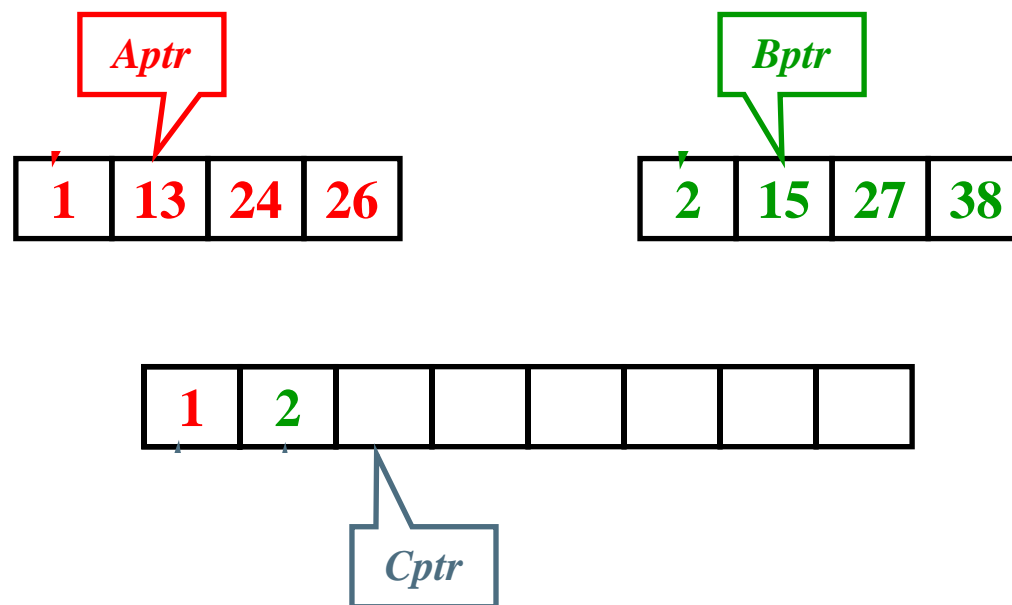


第九讲 排序（上）

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9.4 归并排序

核心：有序子列的归并



如果两个子列一共有 N 个元素，则归并的时间复杂度是？

$$T(N) = O(N)$$

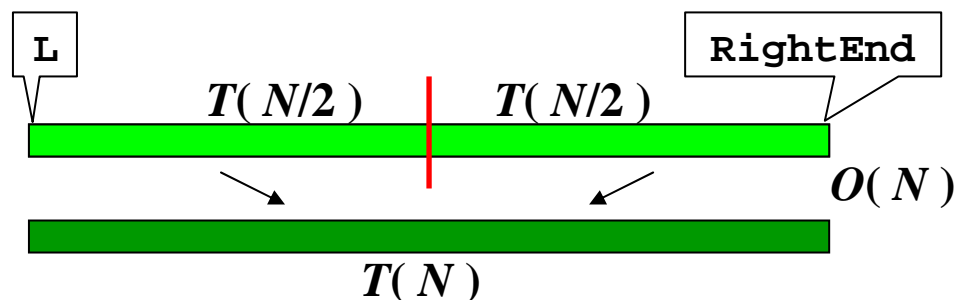
核心：有序子列的归并

```
/* L = 左边起始位置, R = 右边起始位置, RightEnd = 右边终点位置 */
void Merge( ElementType A[], ElementType TmpA[],
            int L, int R, int RightEnd )
{
    LeftEnd = R - 1; /* 左边终点位置。假设左右两列挨着 */
    Tmp = L; /* 存放结果的数组的初始位置 */
    NumElements = RightEnd - L + 1;
    while( L <= LeftEnd && R <= RightEnd ) {
        if ( A[L] <= A[R] ) TmpA[Tmp++] = A[L++];
        else
            TmpA[Tmp++] = A[R++];
    }
    while( L <= LeftEnd ) /* 直接复制左边剩下的 */
        TmpA[Tmp++] = A[L++];
    while( R <= RightEnd ) /* 直接复制右边剩下的 */
        TmpA[Tmp++] = A[R++];
    for( i = 0; i < NumElements; i++, RightEnd -- )
        A[RightEnd] = TmpA[RightEnd];
}
```

递归算法

稳定

■ 分而治之



```
void MSort( ElementType A[], ElementType TmpA[],
            int L, int RightEnd )
{
    int Center;
    if ( L < RightEnd ) {
        Center = ( L + RightEnd ) / 2;
        MSort( A, TmpA, L, Center );
        MSort( A, TmpA, Center+1, RightEnd );
        Merge( A, TmpA, L, Center+1, RightEnd );
    }
}
```

$$T(N) = T(N/2) + T(N/2) + O(N) \quad \rightarrow \quad T(N) = O(N \log N)$$

递归算法

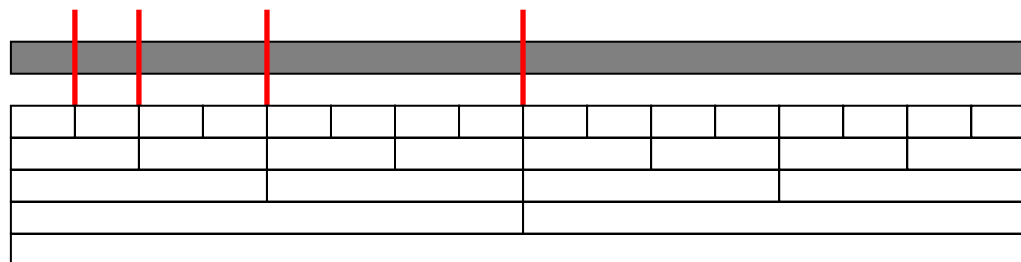


■ 统一函数接口

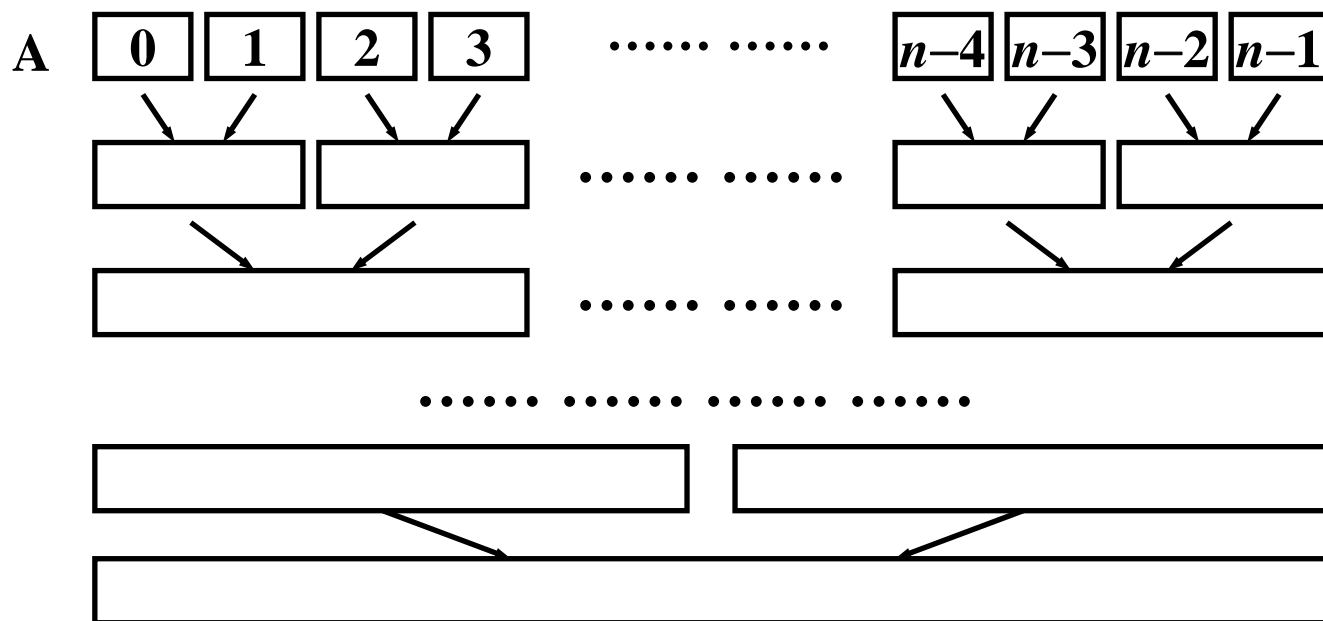
```
void Merge_sort( ElementType A[], int N )
{
    ElementType *TmpA;
    TmpA = malloc( N * sizeof( ElementType ) );
    if ( TmpA != NULL ) {
        MSort( A, TmpA, 0, N-1 );
        free( TmpA );
    }
    else Error( "空间不足" );
}
```

递归算法

- 如果只在Merge中声明临时数组
 - ❑ `void Merge(ElementType A[], int L, int R, int RightEnd)`
 - ❑ `void MSort(ElementType A[], int L, int RightEnd)`



非递归算法



额外空间复杂度是??? $O(N)$

非递归算法

将A中元素归并到TmpA

```
void Merge_pass( ElementType A[], ElementType TmpA[], int N,
    int length ) /* length = 当前有序子列的长度 */
{
    for ( i=0; i <= N-2*length; i += 2*length )
        Merge1( A, TmpA, i, i+length, i+2*length-1 );
    if ( i+length < N ) /* 归并最后2个子列 */
        Merge1( A, TmpA, i, i+length, N-1);
    else /* 最后只剩1个子列 */
        for ( j = i; j < N; j++ ) TmpA[j] = A[j];
}
```

非递归算法

```
void Merge_sort( ElementType A[], int N )
{
    ElementType *TmpA;
    TmpA = malloc( N * sizeof( ElementType ) );
    if ( TmpA != NULL ) {
        while( length < N ) {
            Merge_pass( A, TmpA, N, length );
            length *= 2;
            Merge_pass( TmpA, A, N, length );
            length *= 2;
        }
        free( TmpA );
    }
    else Error( "空间不足" );
}
```

稳定