HEAP SORT

A = {12, 2, 8, 5, 1, 6, 4, 15}

**Phần tử liên đới của i 🡪 (2\*i + 1, 2\*i + 2)**

**A[i] > A[2\*i + 1]**

**A[i] > A[2\*i + 2]**

Hiệu chỉnh và sắp xếp trên đoạn n=8

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  | 0 |  |  |  |
|  |  | 1 |  | 12 |  | 2 |  |
|  | 3 | 2 | 4 |  | 5 | 8 | 6 |
| 7 | 5 |  | 1 |  | 6 |  | 4 |
| 15 |  |  |  |  |  |  |  |

Bước 1: Hiệu chỉnh và sắp xếp trên mảng A = {12, 2, 8, 5, 1, 6, 4, 15}, n=8 lần lượt từng vị trí i = n/2 -1 🡪 0

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tại i = 3   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  | 0 |  |  |  | |  |  | 1 |  | 12 |  | 2 |  | |  | 3 | 2 | 4 |  | 5 | 8 | 6 | | 7 | **15** |  | 1 |  | 6 |  | 4 | | **5** |  |  |  |  |  |  |  | | Tại i = 2   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  | 0 |  |  |  | |  |  | 1 |  | 12 |  | 2 |  | |  | 3 | 2 | 4 |  | 5 | 8 | 6 | | 7 | 15 |  | 1 |  | 6 |  | 4 | | 5 |  |  |  |  |  |  |  | |
| Tại i = 1   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  | 0 |  |  |  | |  |  | 1 |  | 12 |  | 2 |  | |  | 3 | **15** | 4 |  | 5 | 8 | 6 | | 7 | **2** |  | 1 |  | 6 |  | 4 | | 5 |  |  |  |  |  |  |  |   Khi hoán vị 2 và 15 làm ảnh hưởng đến nhánh bên dưới 2 trở thành node cha của 5 🡪 Cần hiệu chỉnh tiếp nhánh bên dưới sao cho thõa đk  **A[i] > A[2\*i + 1] và A[i] > A[2\*i + 2]**  Đây gọi là hiệu chỉnh lan truyền   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  | 0 |  |  |  | |  |  | 1 |  | 12 |  | 2 |  | |  | 3 | 15 | 4 |  | 5 | 8 | 6 | | 7 | **5** |  | 1 |  | 6 |  | 4 | | **2** |  |  |  |  |  |  |  | | Tại i = 0   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | |  |  |  |  | 0 |  |  |  | |  |  | 1 |  | **15** |  | 2 |  | |  | 3 | **12** | 4 |  | 5 | 8 | 6 | | 7 | 5 |  | 1 |  | 6 |  | 4 | | 2 |  |  |  |  |  |  |  | |

15, 12, 8, 5, 1, 6, 4, 2 hoán vị vị trí đầu cuối 🡪 2, 12, 8, 5, 1, 6, 4, 15

Bước 2: Hiệu chỉnh và sắp xếp trên mảng A = {2, 12, 8, 5, 1, 6, 4}, n=7 lần lượt từng vị trí i = n/2 -1 🡪 0

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tại i = 2   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  |  | |  | 1 |  | 2 |  | 2 |  | | 3 | 12 | 4 |  | 5 | 8 | 6 | | 5 |  | 1 |  | 6 |  | 4 | |  |  |  |  |  |  |  | | Tại i = 1   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  |  | |  | 1 |  | 2 |  | 2 |  | | 3 | 12 | 4 |  | 5 | 8 | 6 | | 5 |  | 1 |  | 6 |  | 4 | |  |  |  |  |  |  |  | |
| Tại i = 0   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  |  | |  | 1 |  | **12** |  | 2 |  | | 3 | **2** | 4 |  | 5 | 8 | 6 | | 5 |  | 1 |  | 6 |  | 4 | |  |  |  |  |  |  |  |   Hiệu chỉnh lan truyền   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  |  | |  | 1 |  | **12** |  | 2 |  | | 3 | **5** | 4 |  | 5 | 8 | 6 | | **2** |  | 1 |  | 6 |  | 4 | |  |  |  |  |  |  |  | |  |

12, 5, 8, 2, 1, 6, 4 hoán vị vị trí đầu cuối 🡪 4, 5, 8, 2, 1, 6, 12

Bước 3: Hiệu chỉnh và sắp xếp trên mảng A = {4, 5, 8, 2, 1, 6}, n=6 lần lượt từng vị trí i = n/2 -1 🡪 0

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tại i = 2   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  | |  | 1 |  | 4 |  | 2 | | 3 | 5 | 4 |  | 5 | 8 | | 2 |  | 1 |  | 6 |  | |  |  |  |  |  |  | | Tại i = 1   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  | |  | 1 |  | 4 |  | 2 | | 3 | 5 | 4 |  | 5 | 8 | | 2 |  | 1 |  | 6 |  | |  |  |  |  |  |  | |
| Tại i = 0   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  | |  | 1 |  | **8** |  | 2 | | 3 | 5 | 4 |  | 5 | **4** | | 2 |  | 1 |  | 6 |  | |  |  |  |  |  |  |   Hiệu chỉnh lan truyền   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  | |  | 1 |  | 8 |  | 2 | | 3 | 5 | 4 |  | 5 | **6** | | 2 |  | 1 |  | **4** |  | |  |  |  |  |  |  | |  |

8, 5, 6, 2, 1, 4 hoán vị vị trí đầu cuối 🡪 4, 5, 6, 2, 1, 8

Bước 4: Hiệu chỉnh và sắp xếp trên mảng A = {4, 5, 6, 2, 1}, n=5 lần lượt từng vị trí i = n/2 -1 🡪 0

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Tại i = 2   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  | |  | 1 |  | 4 |  | 2 | | 3 | 5 | 4 |  |  | 6 | | 2 |  | 1 |  |  |  | |  |  |  |  |  |  | | Tại i = 1   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  | |  | 1 |  | 6 |  | 2 | | 3 | 5 | 4 |  |  | 4 | | 2 |  | 1 |  |  |  | |  |  |  |  |  |  | |
| Tại i = 0   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | |  |  |  | 0 |  |  | |  | 1 |  | **6** |  | 2 | | 3 | 5 | 4 |  |  | **4** | | 2 |  | 1 |  |  |  | |  |  |  |  |  |  | |  |

6, 5, 4, 2, 1 hoán vị vị trí đầu cuối 🡪 1, 5, 4, 2, 6

Tương tự các bước còn lại ta có kết quả mảng A đã được sắp xếp

A = {1, 2, 4, 5, 6, 8, 12, 15}

QUICK SORT

A = {12, 2, 8, 5, 1, 6, 4, 15}

Chọn tùy ý phần tử X trong đoạn [left, right] 🡪 chọn phần tử ở giữa

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Left = 0 | 1 | 2 | 3 | 4 | 5 | 6 | Right = 7 |
| 12 | 2 | 8 | 5 | 1 | 6 | 4 | 15 |

A[i] < X 🡪 i++

A[j] > X 🡪 j++

Bước 1: xét trên đoạn [0,7] và X = 5

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| i = 0 | 1 | 2 | 3 | 4 | 5 | j=6 | j = 7 |
| 12 | 2 | 8 | 5 | 1 | 6 | 4 | 15 |

Hoán vị (12, 4) 🡪 Kết quả:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | i=2 | 3 | j=4 | 5 | 6 | 7 |
| 4 | 2 | 8 | 5 | 1 | 6 | 12 | 15 |

Hoán vị (8,1) 🡪 Kết quả:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | i=3=j | 4 | 5 | 6 | 7 |
| 4 | 2 | 1 | 5 | 8 | 6 | 12 | 15 |

* i = j 🡪 Phân hoạch 2 đoạn [0,3] và [3,7]

Bước 2.1: Xét trên đoạn [0,3] và X = 2

|  |  |  |  |
| --- | --- | --- | --- |
| i = 0 | 1 | j = 2 | j = 3 |
| 4 | 2 | 1 | 5 |

Hoán vị (4,1) 🡪 Kết quả:

void quickSort(int \*a, int left, int right)

{

if (left >= right) return;

int x = a[0], i = left, j = right;

while(i < j)

{

while (a[i] < x) i++;

while (a[j] > x) j--;

if (i <= j)

{swap(a[i], a[j]); i++; j--; }

}

if(left < j) quickSort(a, left, j);

if(i < right) quickSort(a, i, right);

}

|  |  |  |  |
| --- | --- | --- | --- |
| i = 0 | i=1=j | j = 2 | j = 3 |
| 1 | 2 | 4 | 5 |

* i = j 🡪 Phân hoạch 2 đoạn [0,1] và [1,3]

Bước 2.1.1: Xét trên đoạn [0,1] và X = 1

|  |  |  |
| --- | --- | --- |
|  | i=j=0 | 1 |
|  | 1 | 2 |

Hoán vị (1,1) 🡪 Kết quả:

|  |  |  |
| --- | --- | --- |
| j=-1 | 0 | i=1 |
|  | 1 | 2 |

* **dừng phân hoạch do left > j và i = right**

Bước 2.1.2: Xét trên đoạn [1,3] và X = 4

Bước 2.2: Xét trên đoạn [3,7] và X = 6

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| i = 3 | i = 4 | j = 5 | 6 | j = 7 |
| X = 5 | 8 | 6 | 12 | 15 |

Hoán vị (8,6) 🡪 Kết quả:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| 3 | j = 4 | i = 5 | 6 | 7 |
| X = 5 | 6 | 8 | 12 | 15 |

* i > j 🡪 Phân hoạch 2 đoạn [3,4] và [5,7]

Bước 2.2.1: Xét trên đoạn [3,4] và X = 5

Bước 2.2.2: Xét trên đoạn [5,7] và X = 8

A = {12, 2, 8, 5, 1, 6, 4, 15}, n = 8

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 12 | 2 | 8 | 5 | 1 | 6 | 4 | 15 |

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| A1:   |  |  |  |  | | --- | --- | --- | --- | | 12 | 8 | 1 | 4 | | A2:   |  |  |  |  | | --- | --- | --- | --- | | 2 | 5 | 6 | 15 | | |
| A11:   |  |  | | --- | --- | | 12 | 1 |      |  |  | | --- | --- | | A111:  12 | A112:  1 |        * Trộn A111 với A112     A11:   |  |  | | --- | --- | | 1 | 12 |     A12:   |  |  | | --- | --- | | 8 | 4 |      |  |  | | --- | --- | | A121:  8 | A122:  4 |      * Trộn A121 với A122   A12:   |  |  | | --- | --- | | 4 | 8 |        * Trộn A11 với A12   A11:   |  |  | | --- | --- | | 1 | 12 |   A12:   |  |  | | --- | --- | | 4 | 8 |   A1:   |  |  |  |  | | --- | --- | --- | --- | | 1 | 4 | 8 | 12 | | A21:   |  |  | | --- | --- | | 2 | 6 |      |  |  | | --- | --- | | A211:  2 | A212:  6 |        * Trộn A211 với A212     A21:   |  |  | | --- | --- | | 2 | 6 |     A22:   |  |  | | --- | --- | | 5 | 15 |     ……    A22:   |  |  | | --- | --- | | 5 | 15 |     ….                      A2:   |  |  |  |  | | --- | --- | --- | --- | | 2 | 5 | 6 | 15 | | |
| Trộn A1 với A2:    A1:   |  |  |  |  | | --- | --- | --- | --- | | 1 | 4 | 8 | 12 |   A2:   |  |  |  |  | | --- | --- | --- | --- | | 2 | 5 | 6 | 15 |     A:   |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | | 1 | 2 | 4 | 5 | 6 | 8 | 12 | 15 | | | |