Bölüm 8: Öncelikli Kuyruk

Veri Yapıları

Sercan KÜLCÜ, Tüm hakları saklıdır.

Öncelikli Kuyruk (Priority Queue)

- Öğeler öncelik sırasına göre saklanır.
- Öncelikli işlemlerin yönetiminde kullanılır.
- Kuyruktan en yüksek öncelikli öğeyi çıkarmak için O(1) zaman yeterlidir.

Sercan KÜLCÜ, Tüm hakları saklıdır.

Temel Kavramlar

- **Öncelik Kuyruğu**: Öğelerin saklandığı yapı.
- **Öncelik**: Her öğeye atanan öncelik değeri.
- **En Yüksek Öncelik**: Kuyruğun başında bulunan düğümün öncelik değeri.
- **FIFO İlkesi**: Eşit öncelikteki öğeler arasındaki sıra.

Sercan KÜLCÜ, Tüm hakları saklıdır.

Kullanım Alanları

- **İşletim Sistemleri**: Görev sıralamasında kullanılır.
- **Çizge Algoritmaları**: Dijkstra ve A* algoritmaları gibi.
- **Acil Durum Yönetimi**: Hasta sıralaması ve olay yönetimi.
- **Veri Sıkıştırma**: Huffman kodlaması.

Sercan KÜLCÜ, Tüm hakları saklıdır.

Temel İşlemler

- **Ekleme (Insertion):** Öğe eklenirken konumu önceliğine göre bulunur.
- **Çıkarma (Extraction):** En yüksek öncelikli öğe çıkarılır.
- **Sorgulama (Peek):** Öncelikli öğeyi döndürür, kuyruktan çıkarmaz.
- **Boş mu (isEmpty):** Kuyruğun boş olup olmadığını söyler.

Sercan KÜLCÜ, Tüm hakları saklıdır.

Dizi Temsili

- Öğeler basit bir şekilde dizide tutulur.
- Öncelikli öğe dizinin başında saklanır.
- Öğe ekleme ve çıkarma işlemlerinden sonra sıralama bozulabilir.
- Dizinin her işlemden sonra sıralı kalması zor ve karmaşık olabilir.

Sercan KÜLCÜ, Tüm hakları saklıdır.

Bağlı Liste Temsili

- Öğeler bağlı liste yapısında saklanır.
- Öğeler önceliklerine göre bağlı listede uygun konuma eklenir.
- Öncelikli öğe listenin başında saklanır.

Sercan KÜLCÜ, Tüm hakları saklıdır.

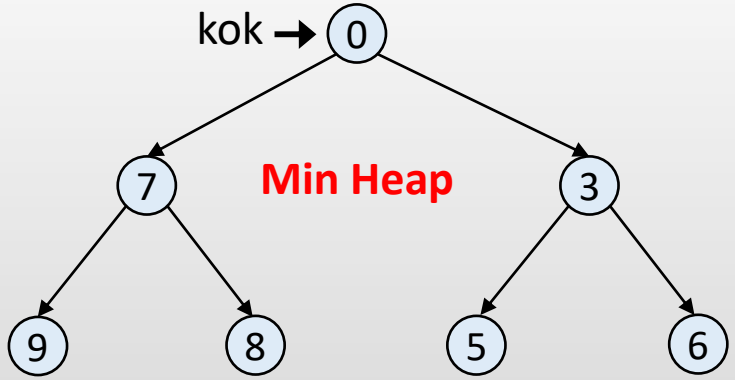
İkili Heap

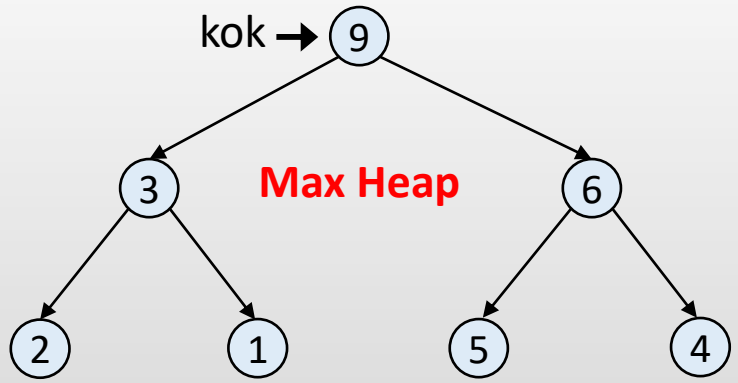
- İkili heap (min-heap veya max-heap) yaygın kullanılan bir veri yapısıdır.
- En yüksek öncelikli öğe kök düğümde bulunur.
- Öğe ekleme ve çıkarma işlemleri O(log n) zaman karmaşıklığına sahiptir.
- Thread-safe değildir.

Sercan KÜLCÜ, Tüm hakları saklıdır.

İkili Heap

- İkili Heap, özel bir ikili ağaç yapısıdır.
- Min-Heap ve Max-Heap olmak üzere iki türü vardır.
- **Min-Heap:** Kök düğümde en düşük öncelik değerine sahip öğe bulunur.
- **Max-Heap:** Kök düğümde en yüksek öncelik değerine sahip öğe bulunur.





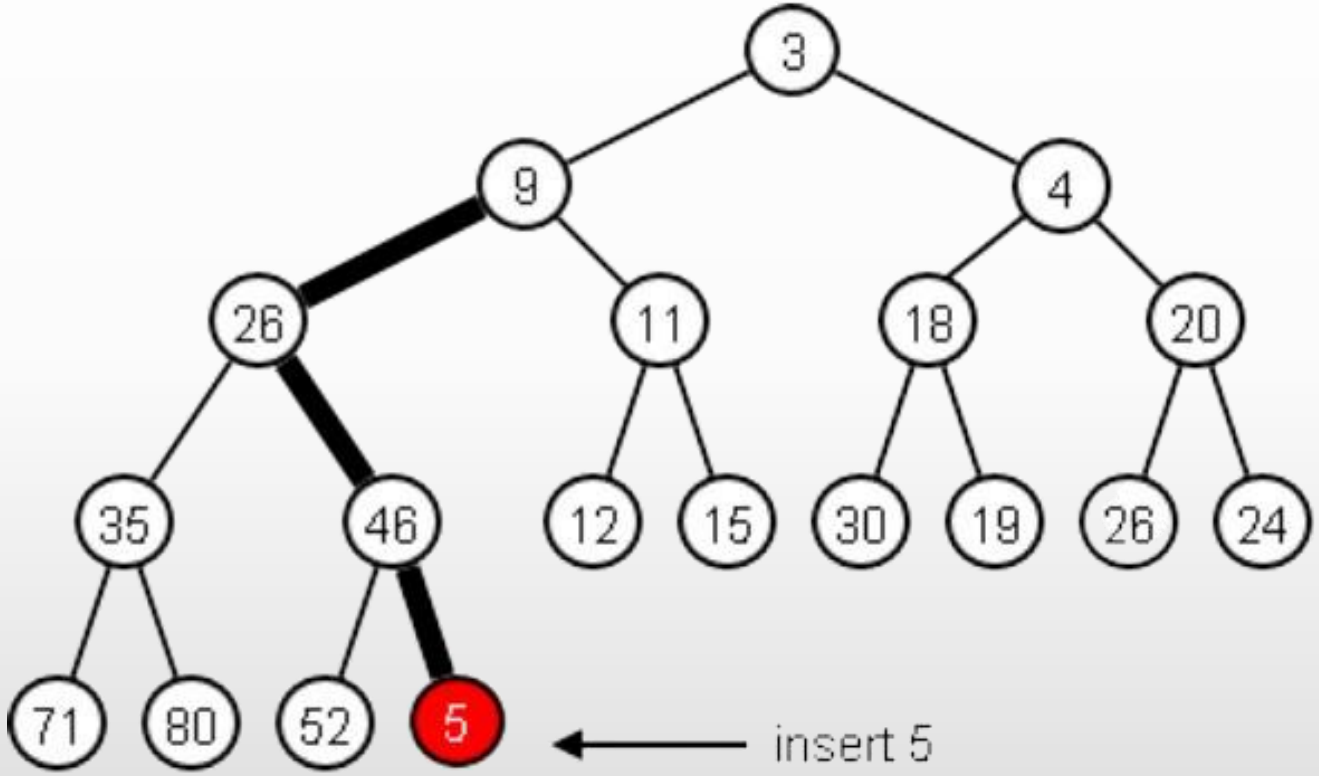
Sercan KÜLCÜ, Tüm hakları saklıdır.

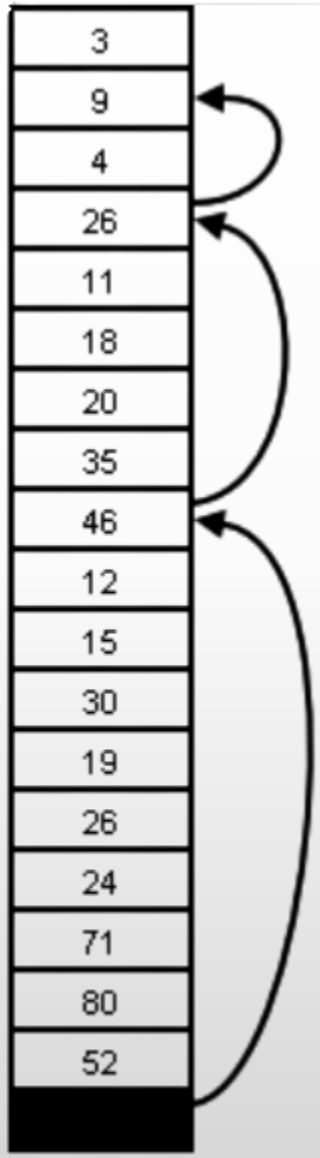
Öğe Ekleme

- Ağacın boşta olan ilk yaprak düğümüne öğe eklenir.
- Öğe ekledikten sonra, ağacın yapısı bozulabilir.
- Max-heap yapısında ata düğüm çocuklarından yüksek değere sahiptir.
- Ağacın tekrar dengelenmesi için "heapify" adı verilen bir işlem yapılır.

Sercan KÜLCÜ, Tüm hakları saklıdır.

Öğe Ekleme





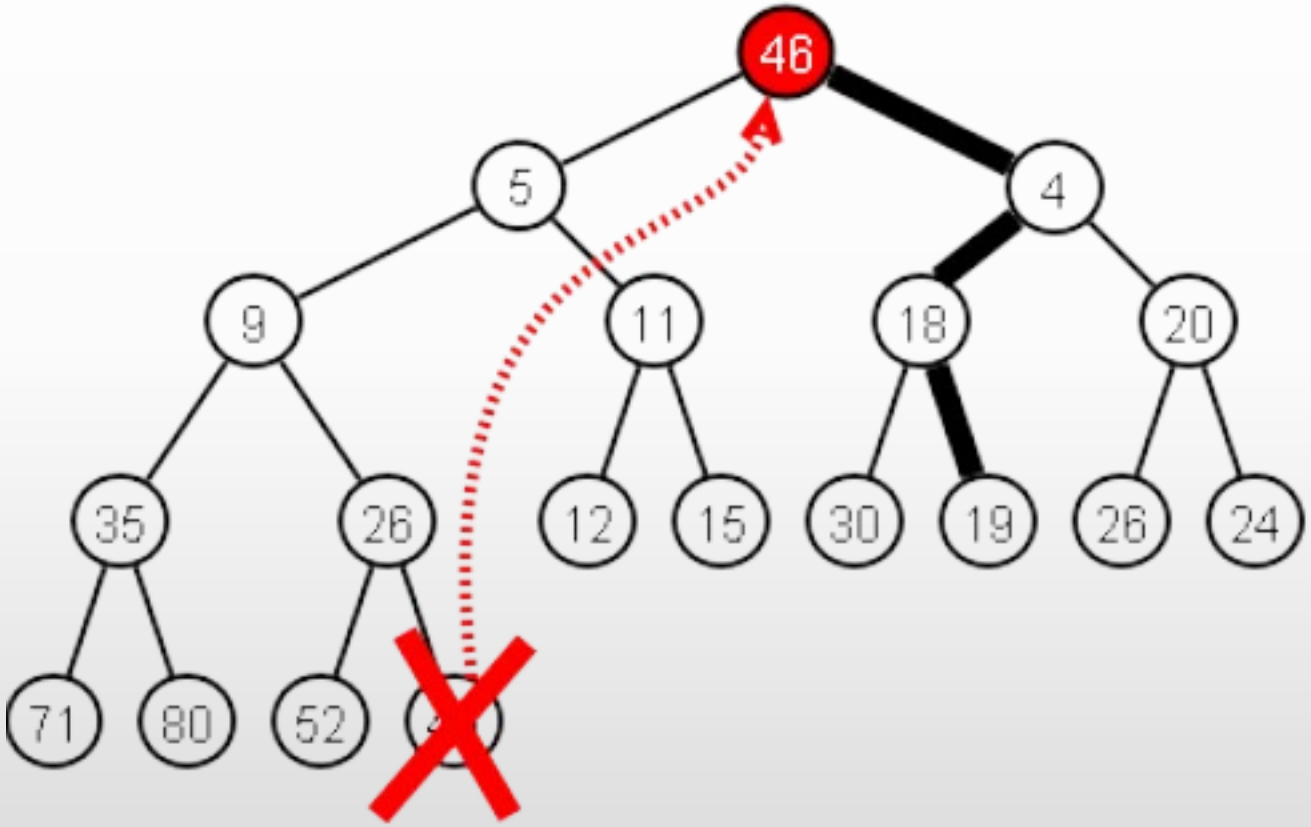
Sercan KÜLCÜ, Tüm hakları saklıdır.

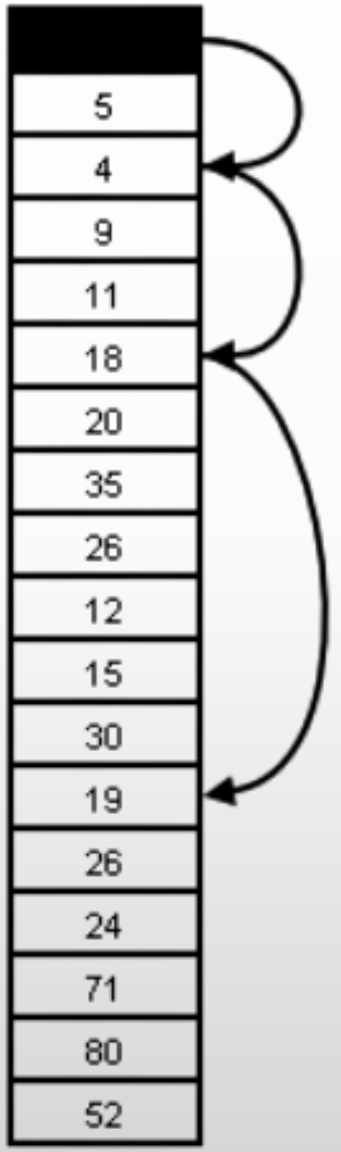
Öğe Çıkarma

- Kök düğümde bulunan öğe çıkarılır.
- Ağacın boş olmayan son yaprak düğümü kök'e taşınır.
- Bu işlemden sonra ağacın yapısı bozulabilir.
- Max-heap yapısında ata düğüm çocuklardan yüksek değere sahiptir.
- Ağacın tekrar dengelenmesi için "heapify" adı verilen bir işlem yapılır.
- heapify işlemi O(log n) zaman karmaşıklığına sahiptir.

Sercan KÜLCÜ, Tüm hakları saklıdır.

Öğe Çıkarma



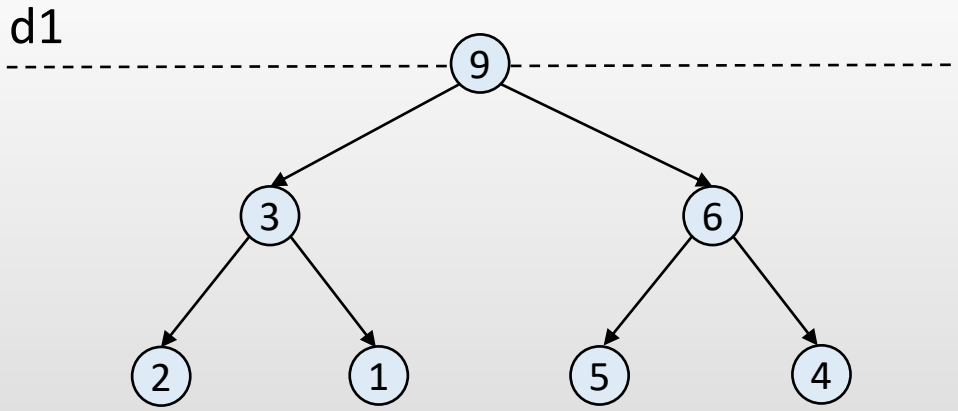


Sercan KÜLCÜ, Tüm hakları saklıdır.

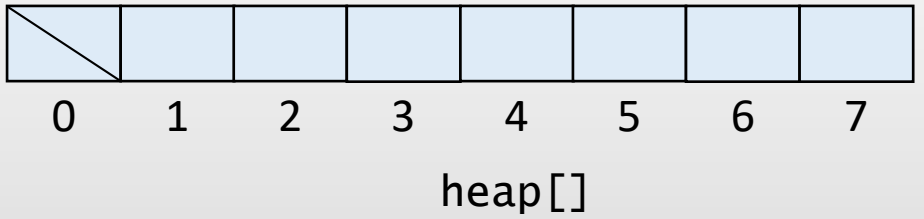
Sercan KÜLCÜ, Tüm hakları saklıdır.

İkili Heap Gösterimi

- Dizinin ilk elemanı boş bırakılır. Heap, tam ikili ağaçtır. Değerler soldan sağa düzey ağaç dolaşımı ile dizi içinde saklanır.



Max Heap



Sercan KÜLCÜ, Tüm hakları saklıdır.

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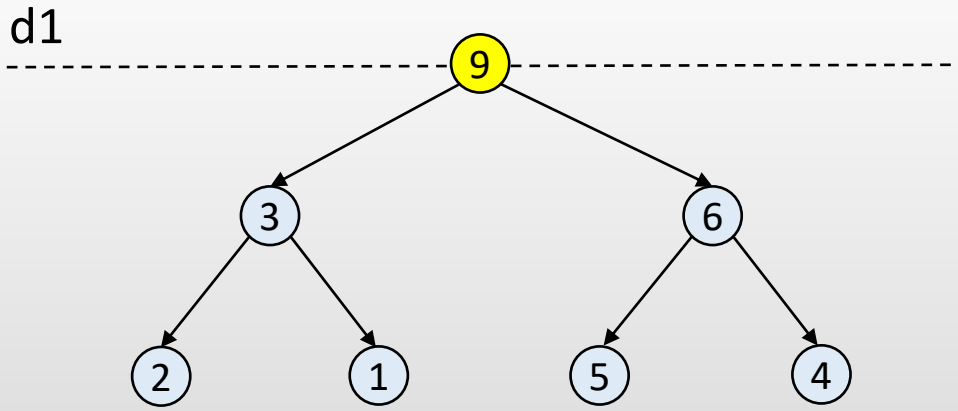

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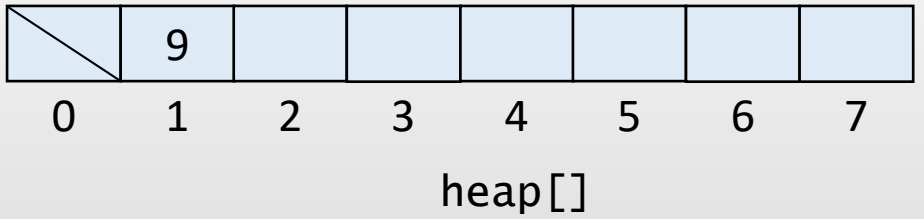

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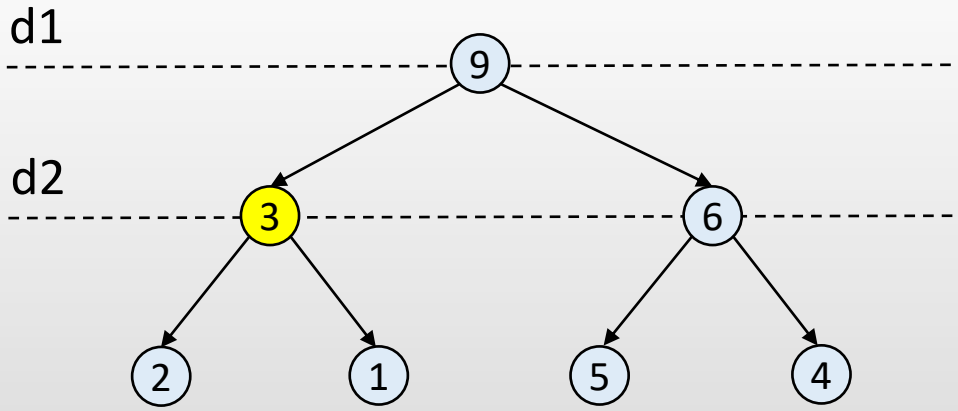
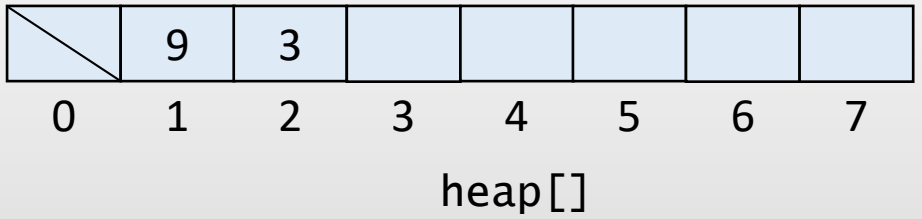


Max Heap



Sercan KÜLCÜ, Tüm hakları saklıdır.

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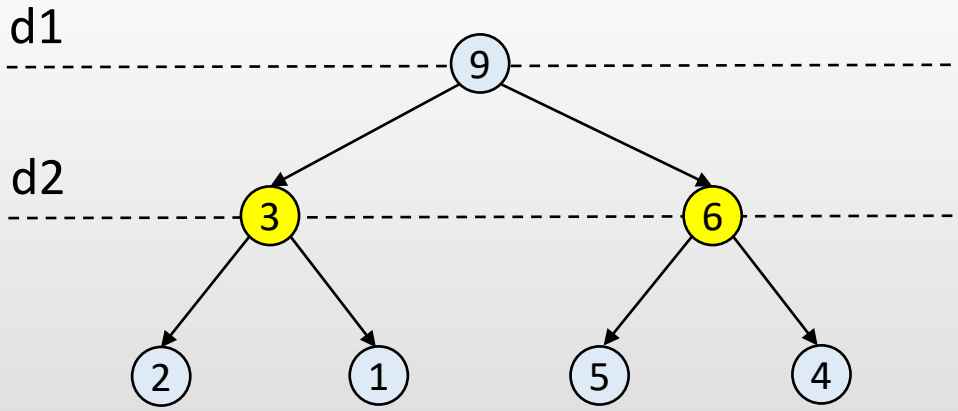
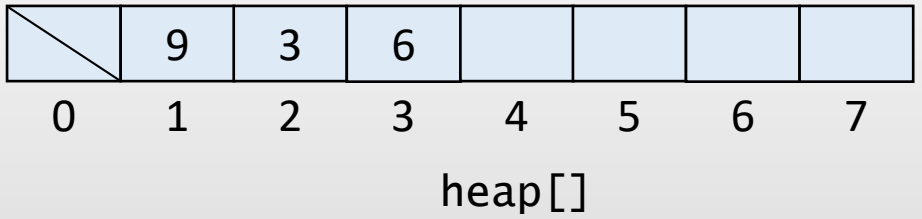


Max Heap



Sercan KÜLCÜ, Tüm hakları saklıdır.

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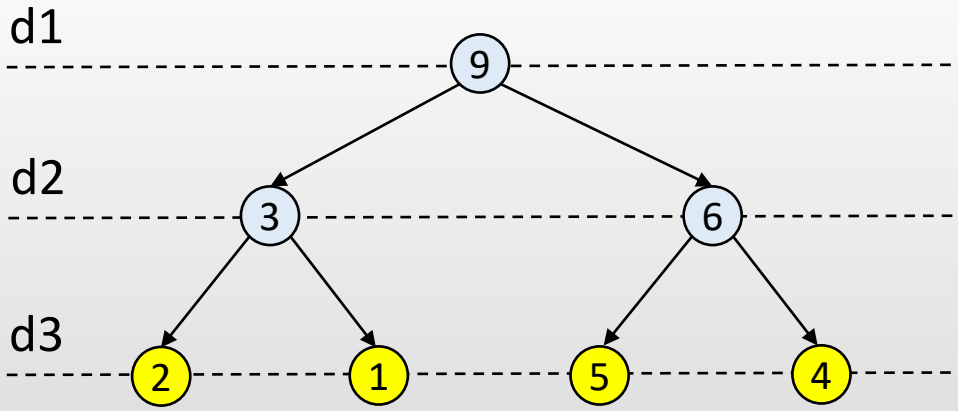
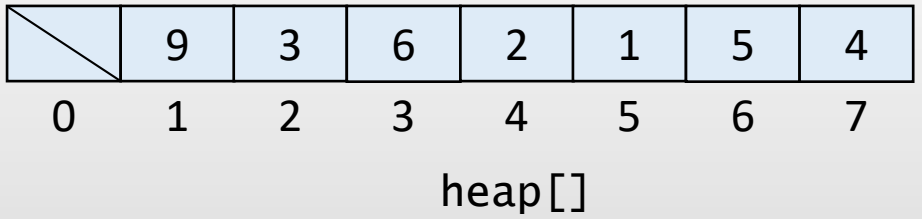


Max Heap



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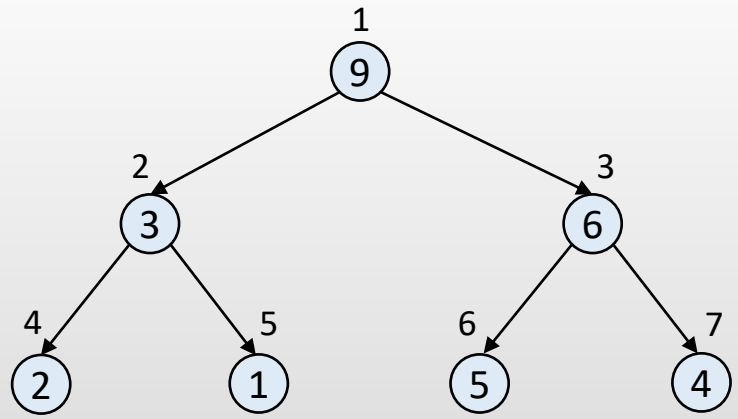
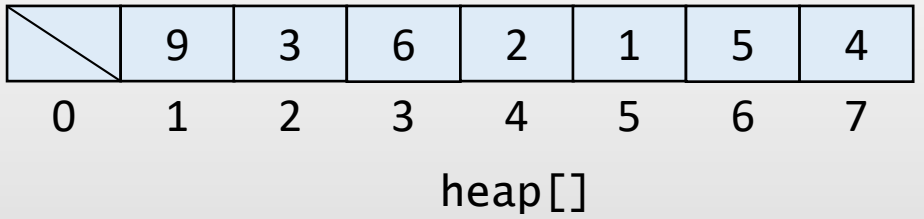


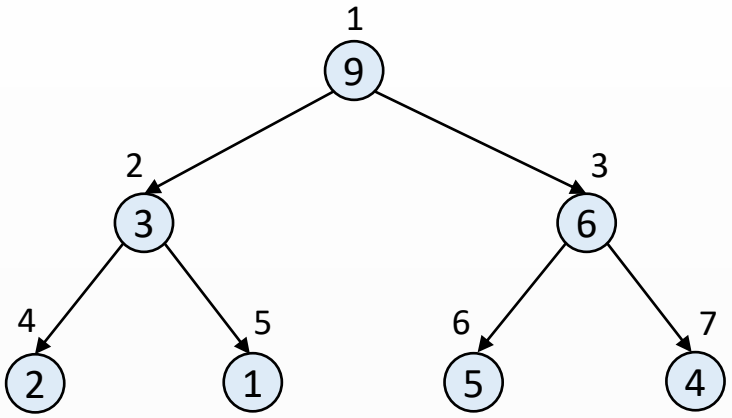
Max Heap



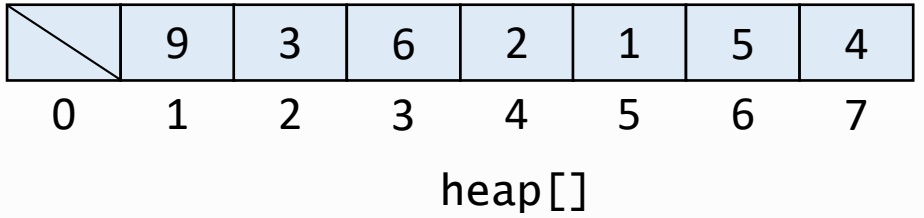
Sercan KÜLCÜ, Tüm hakları saklıdır.

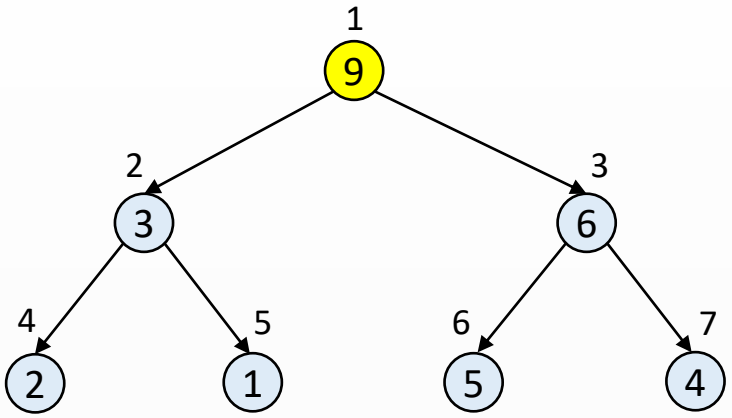
Ata ve Çocuk Hesaplamaları

Sercan KÜLCÜ, Tüm hakları saklıdır.



Max Heap





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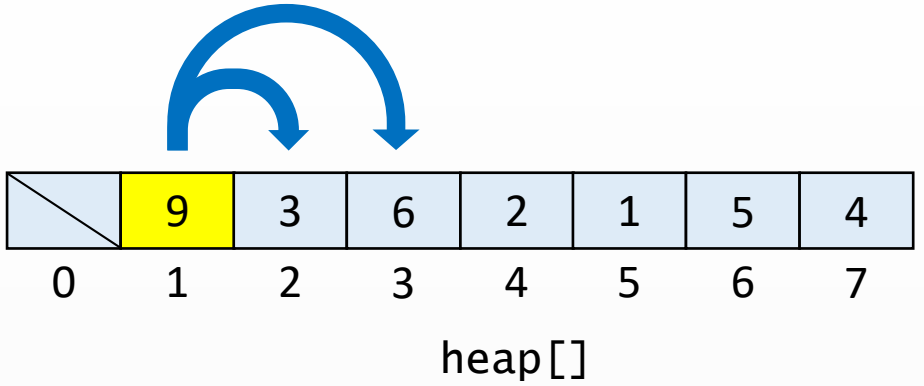

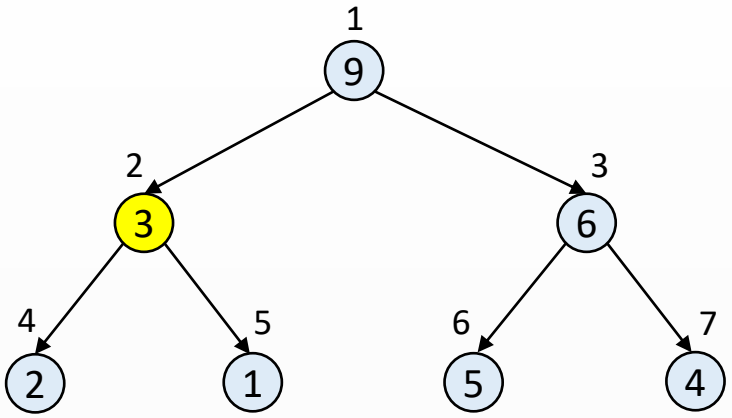

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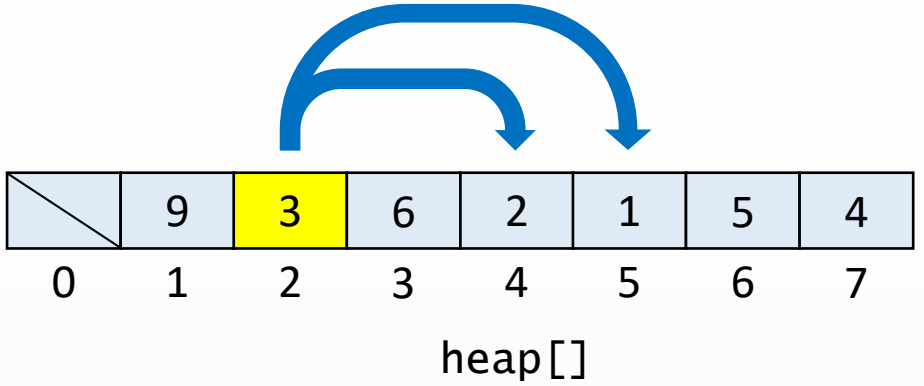
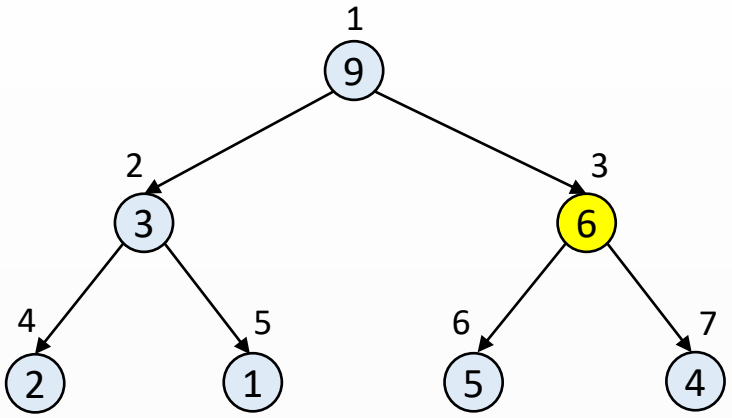
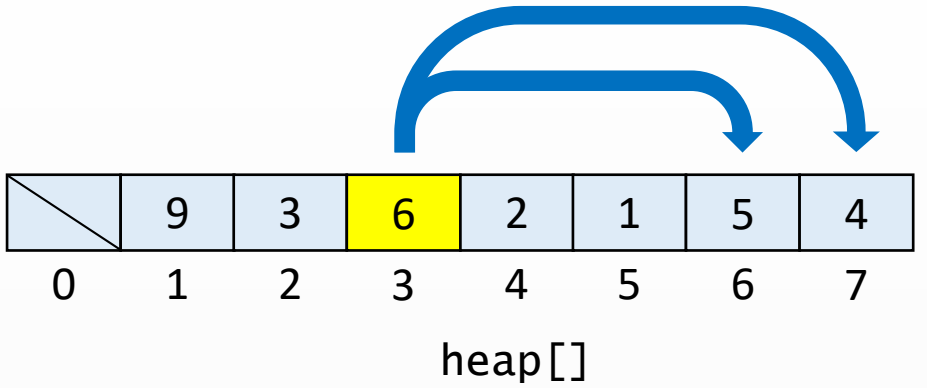




Max Heap



Çocuklar:

indeks 1 → 2, 3

indeks 2 → 4, 5

indeks 3 → 6, 7

indeks k → 2*k, 2*k + 1

Ata:

indeks 7 → ⌊ 7/2 ⌋ = 3

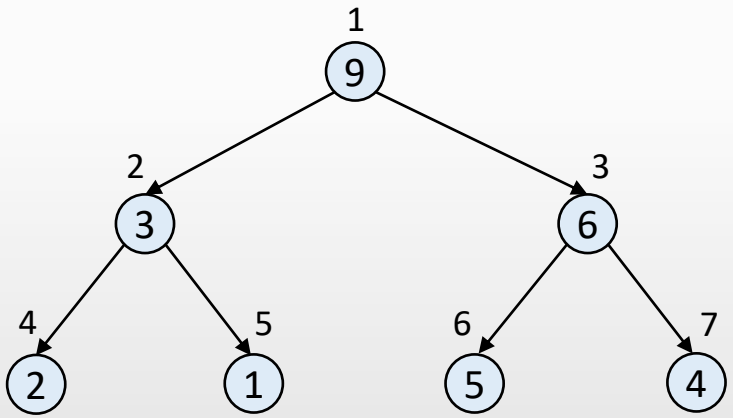
indeks 6 → ⌊ 6/2 ⌋ = 3

indeks 5 → ⌊ 5/2 ⌋ = 2

indeks k → ⌊ k/2 ⌋

İkili Max Heap Ağacı

- Her bir düğümün değeri, çocuklarının değerinden büyüktür.
- En büyük değer kök düğümde bulunur. Kök düğümün indeksi 1'dir.



Max Heap

	9	3	6	2	1	5	4
0	1	2	3	4	5	6	7

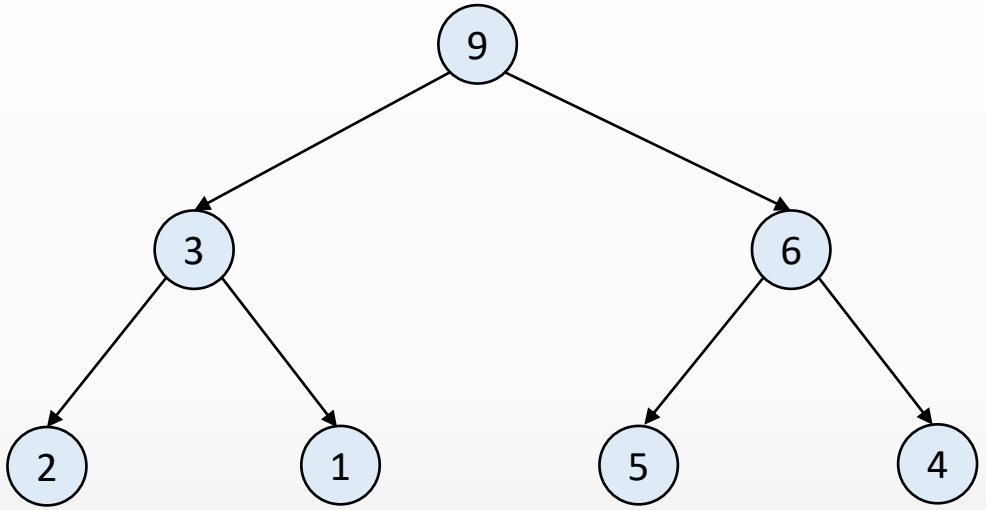
heap[]

Sercan KÜLCÜ, Tüm hakları saklıdır.

Aşağıdan Yukarıya Heap Ağacına Dönüştürme

- Max heap ikili ağacının her bir düğümünün değeri, çocuklarının değerlerinden büyüktür.
- Heap ağacına bir öğe eklendikten sonra bu özellik bozulabilir.
- Bu nedenle öğelerin yerlerinin değiştirilmesi gerekir.
- Ağaç aşağıdan yukarıya doğru taranarak yeniden heap ağacına dönüştürme işlemi (yüzdür - swim) uygulanır (bottom-up heapify).

Sercan KÜLCÜ, Tüm hakları saklıdır.

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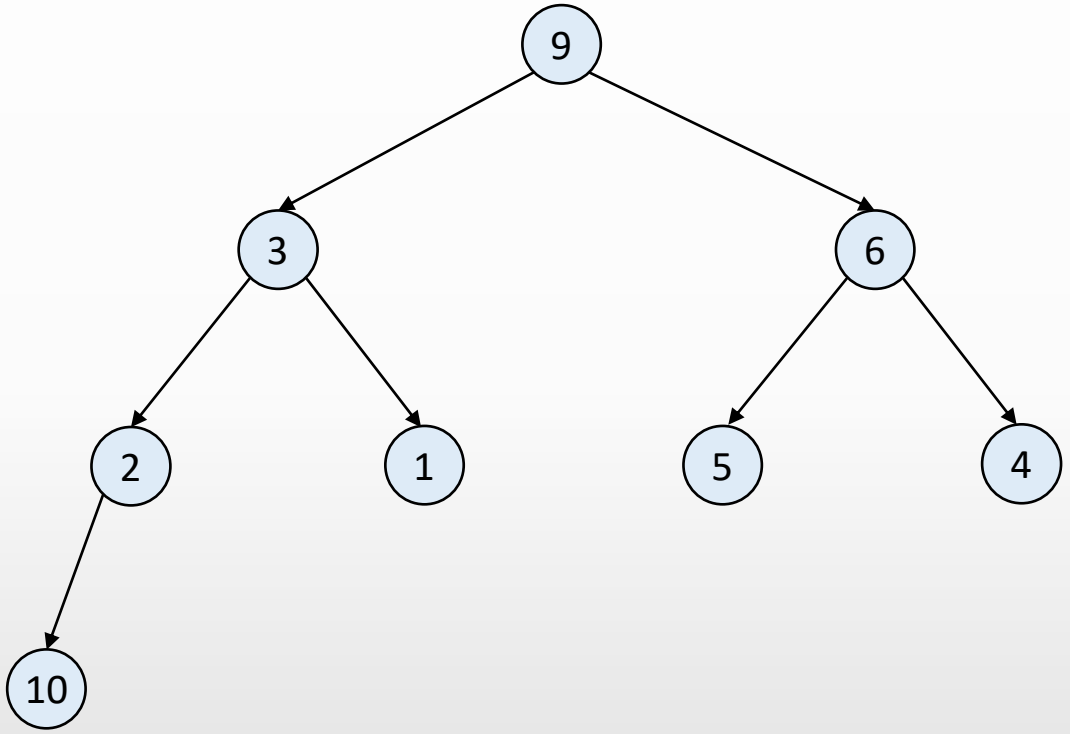


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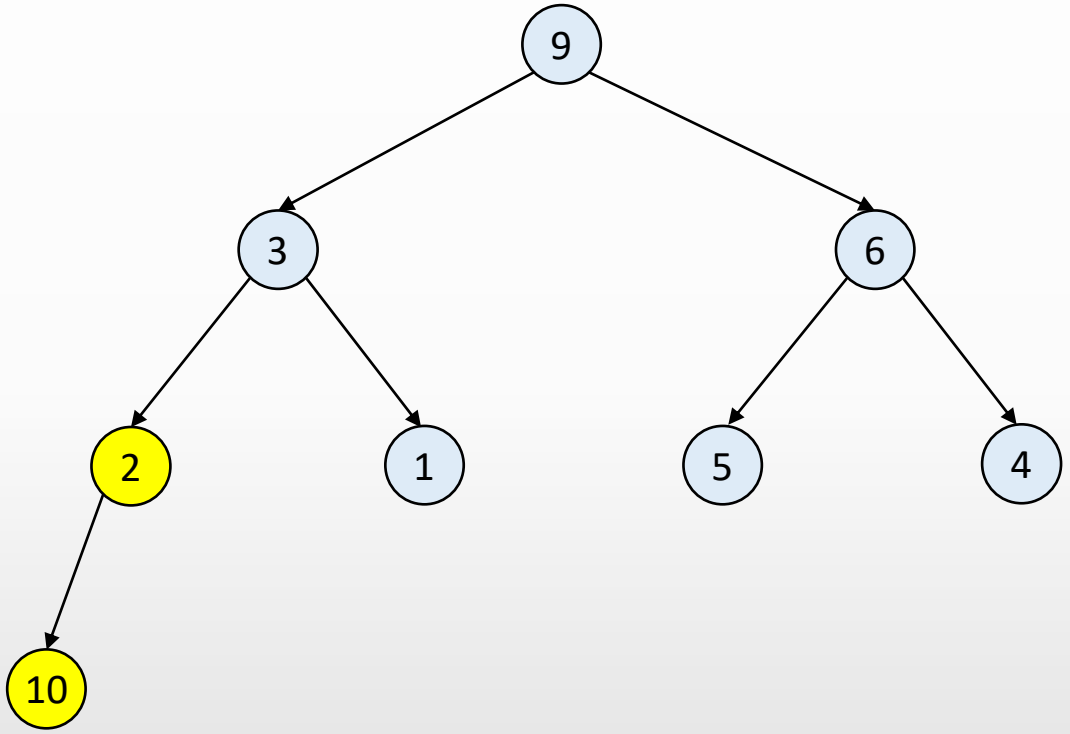


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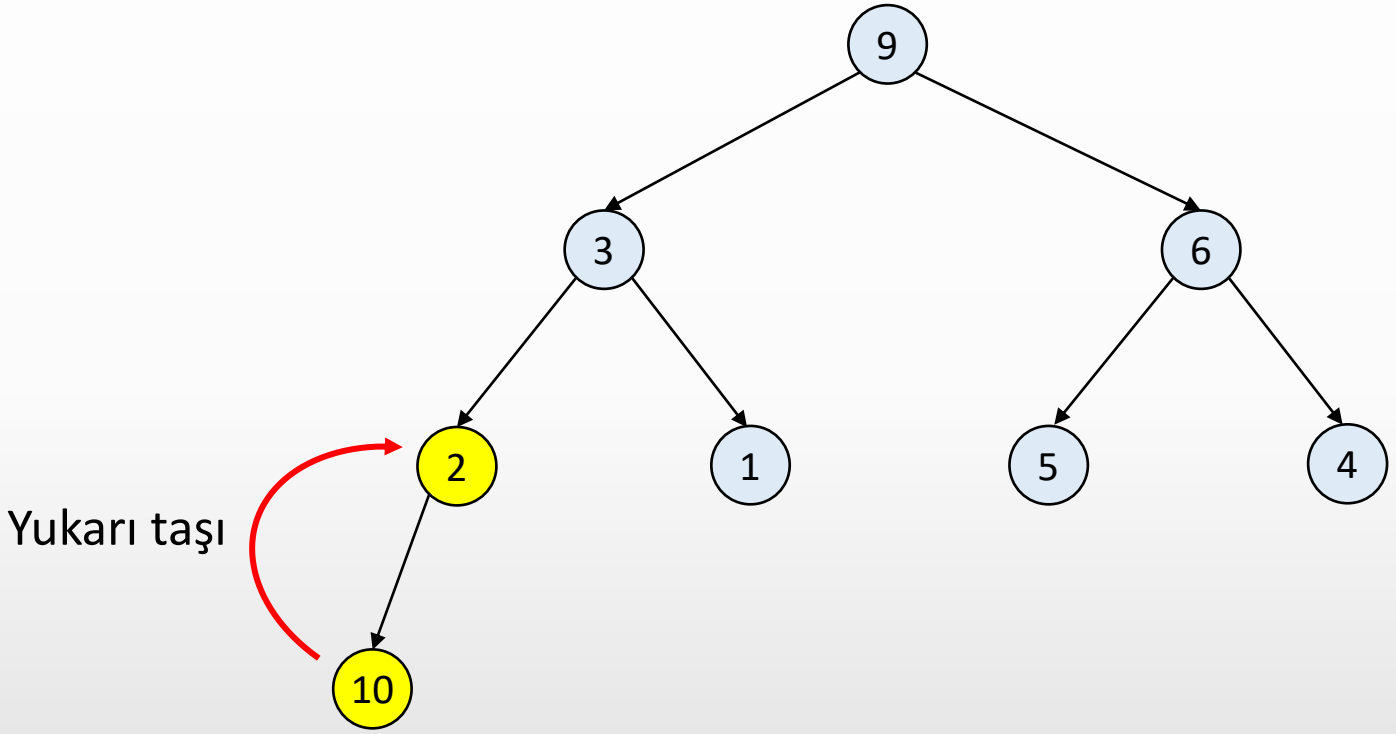


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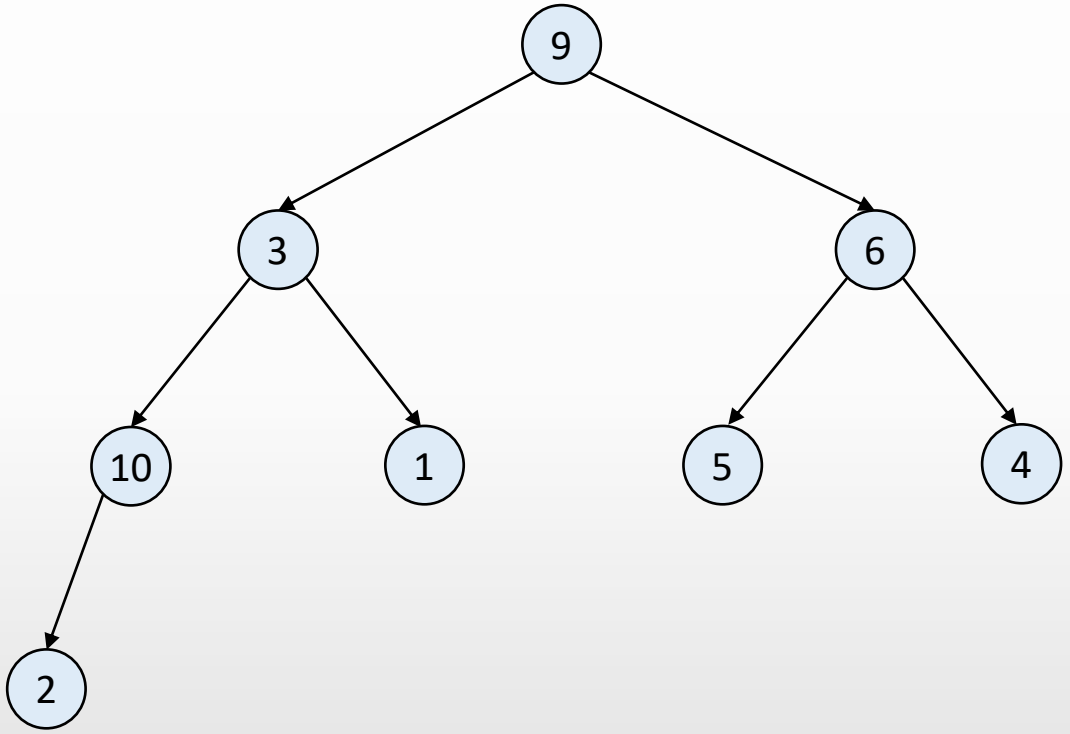


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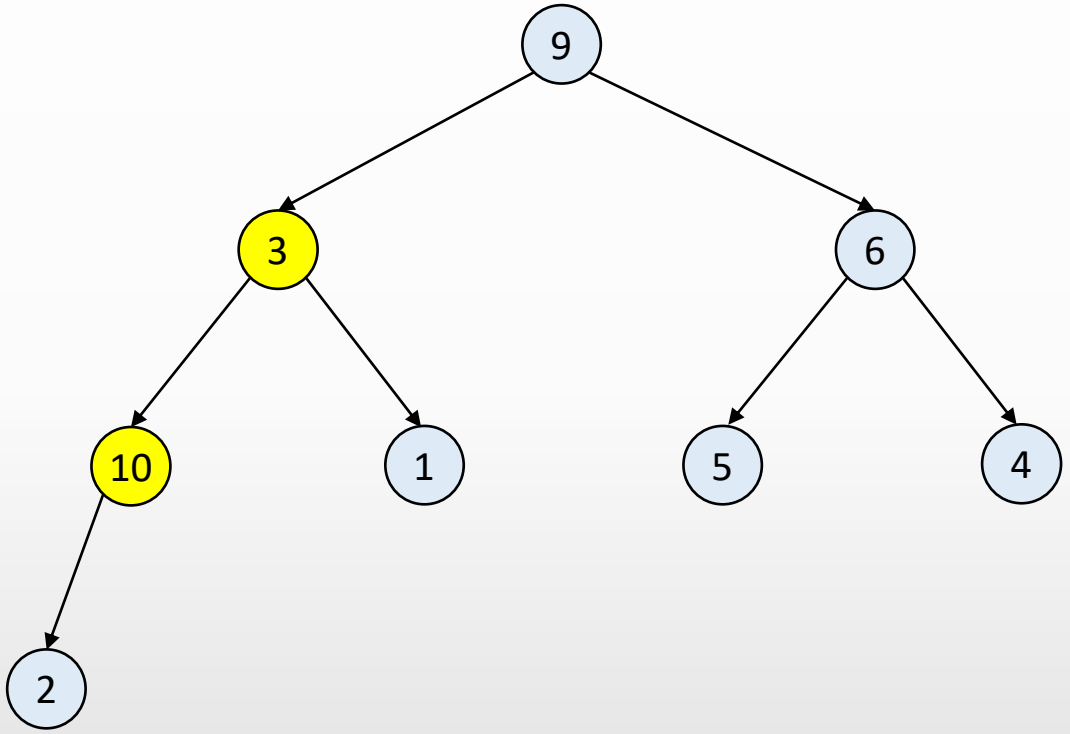


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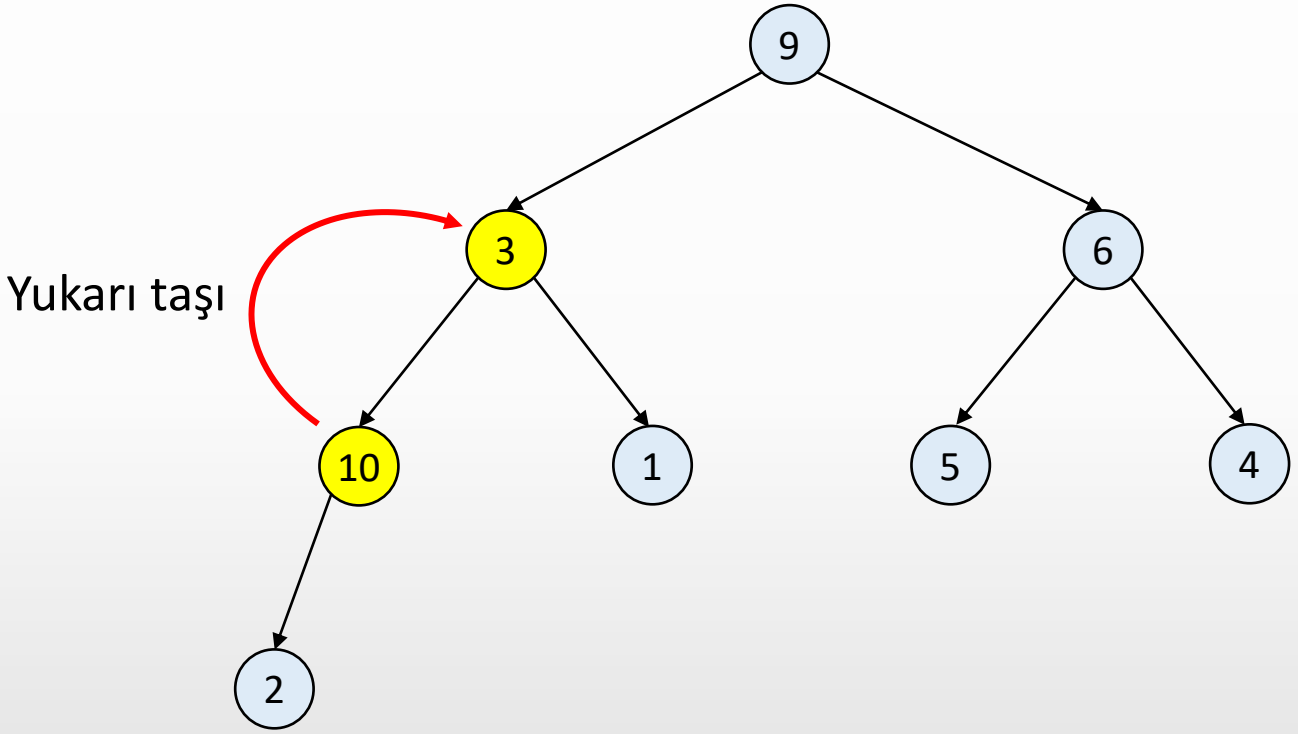


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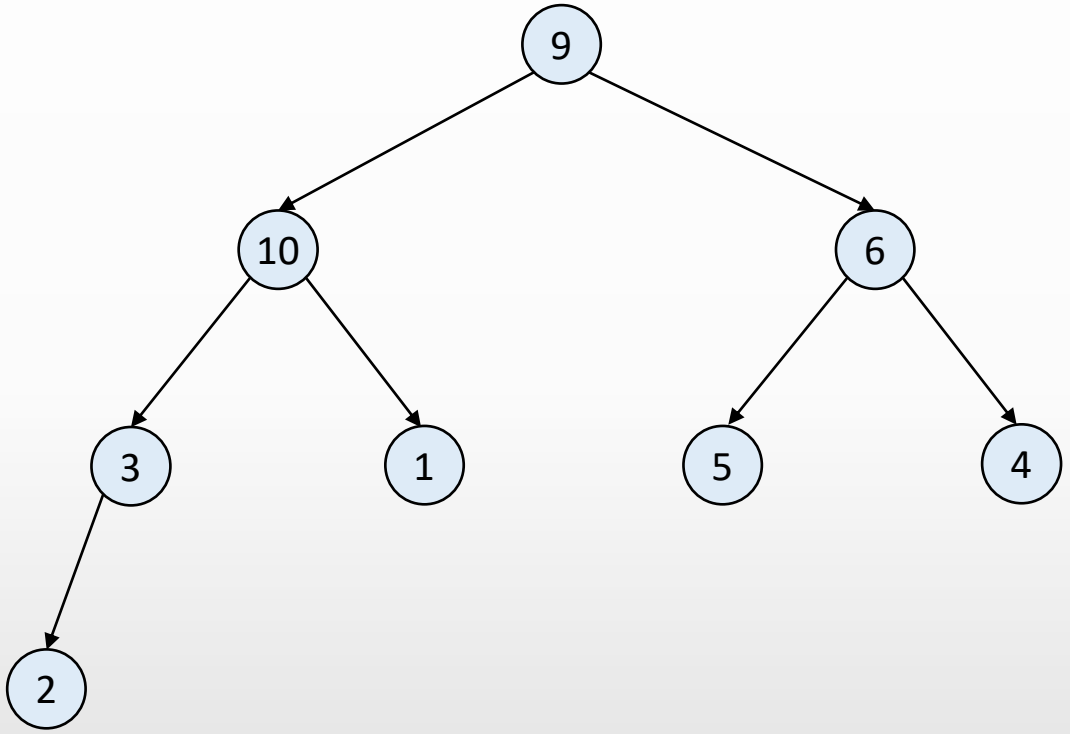


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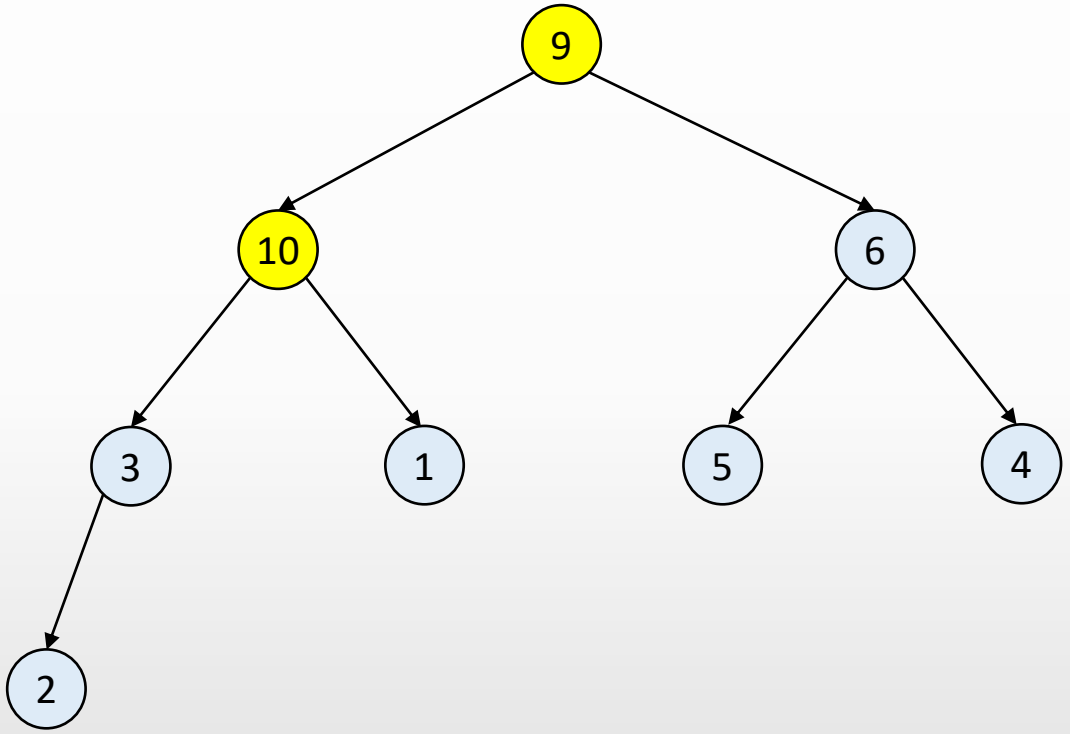


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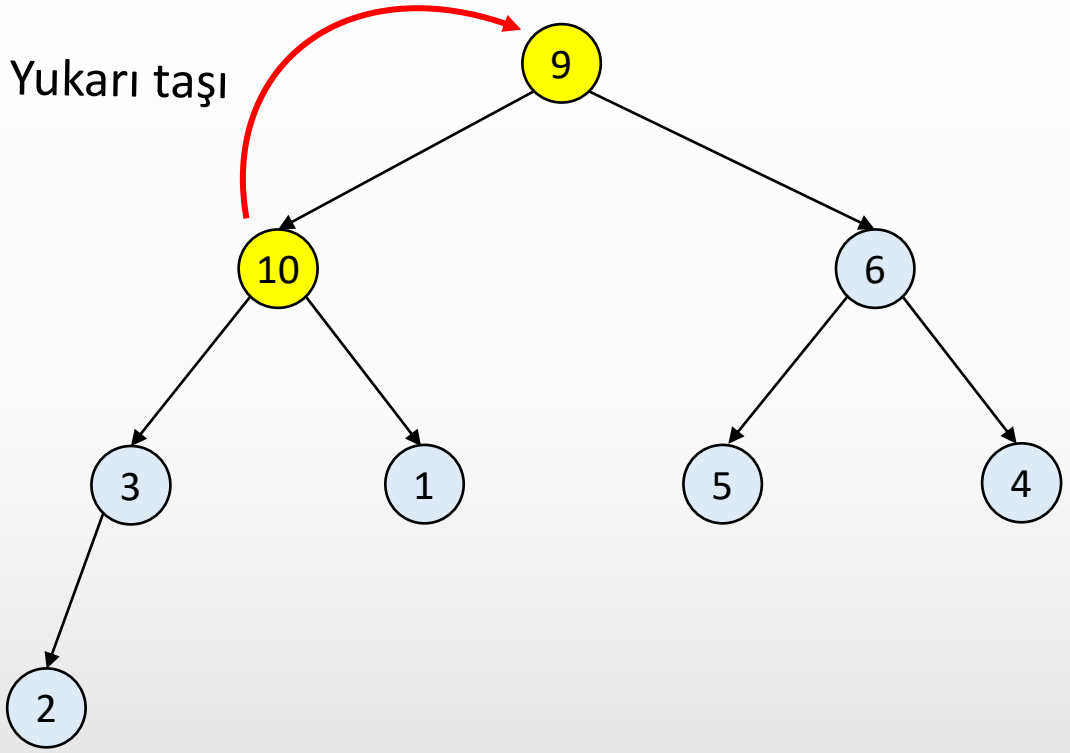
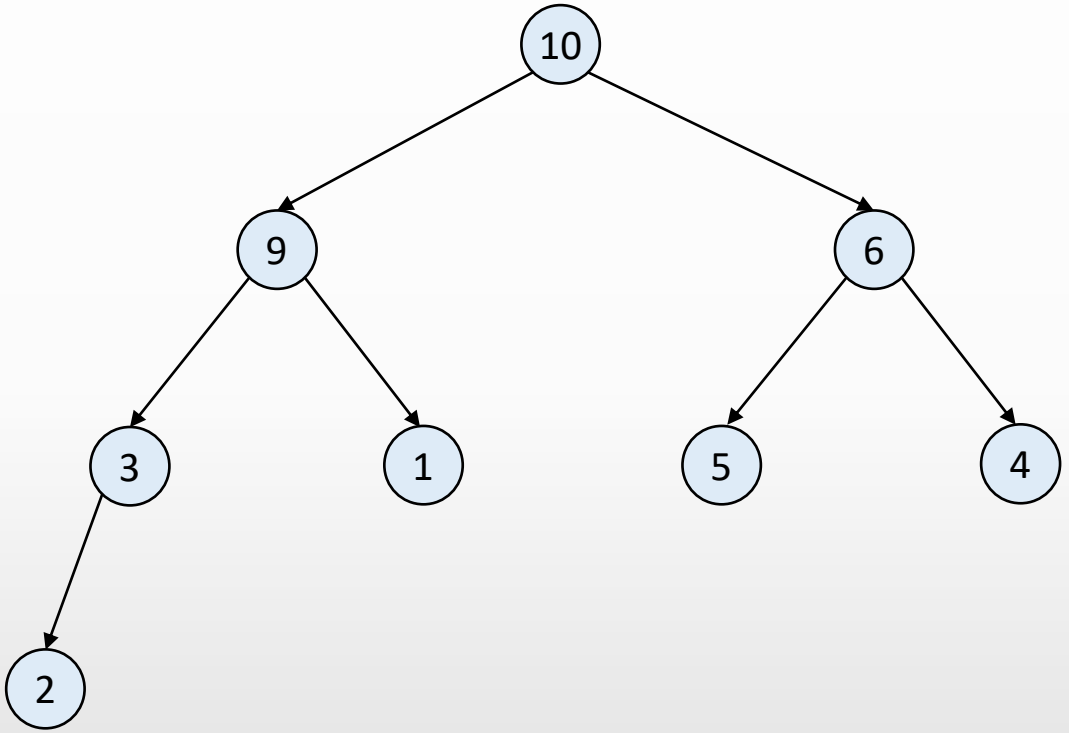
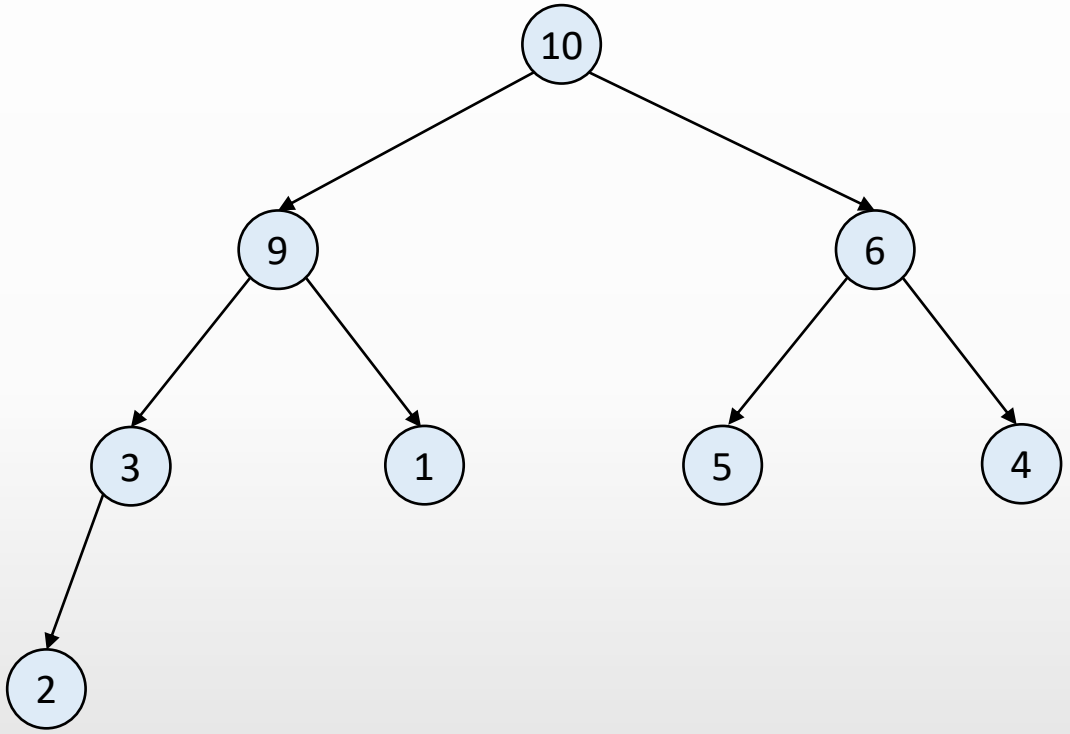
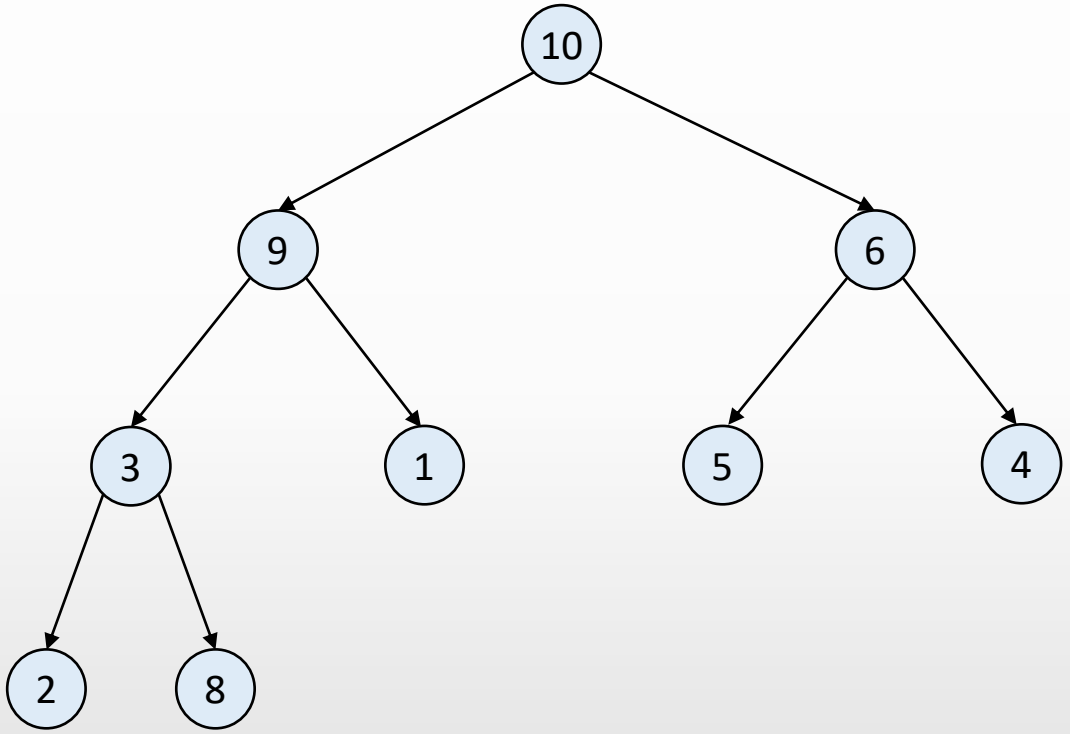



```
ekle(10)
```

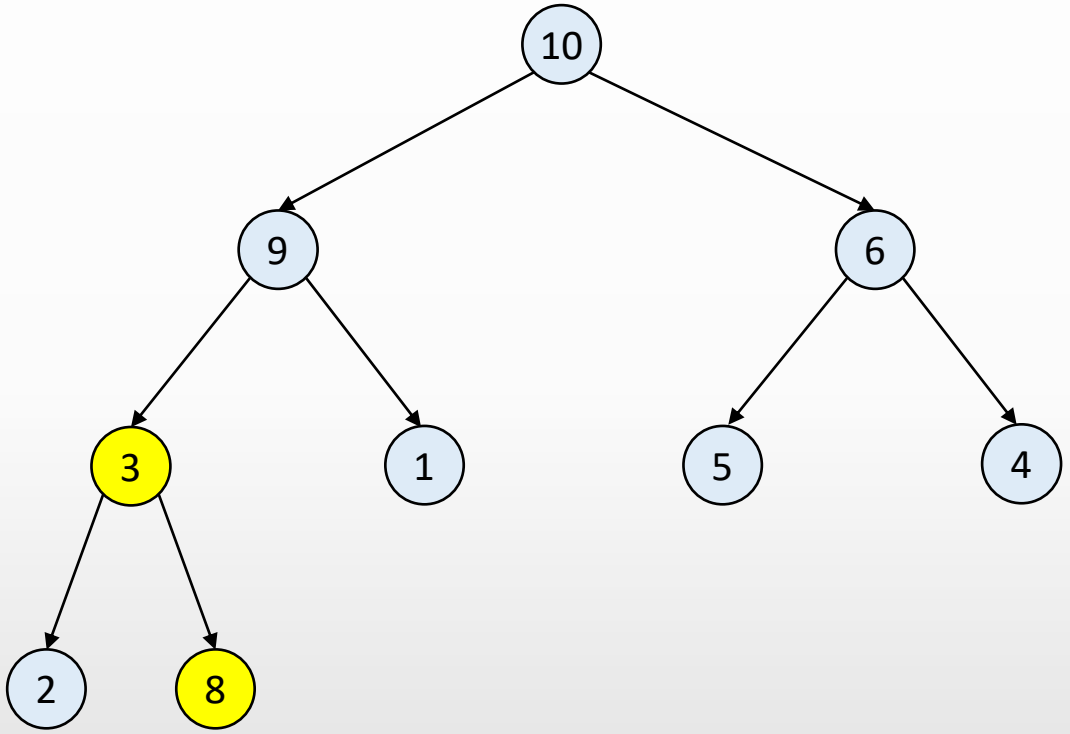

10
9
6
3
1
5
4
2



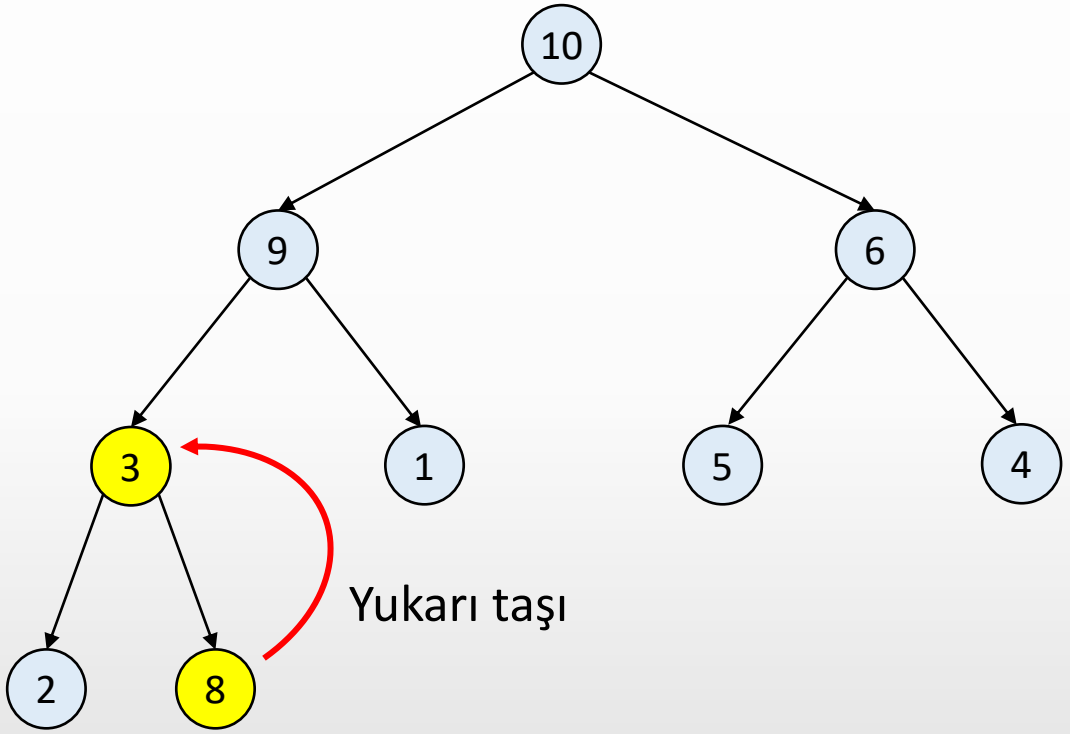

```
ekle(8)
```



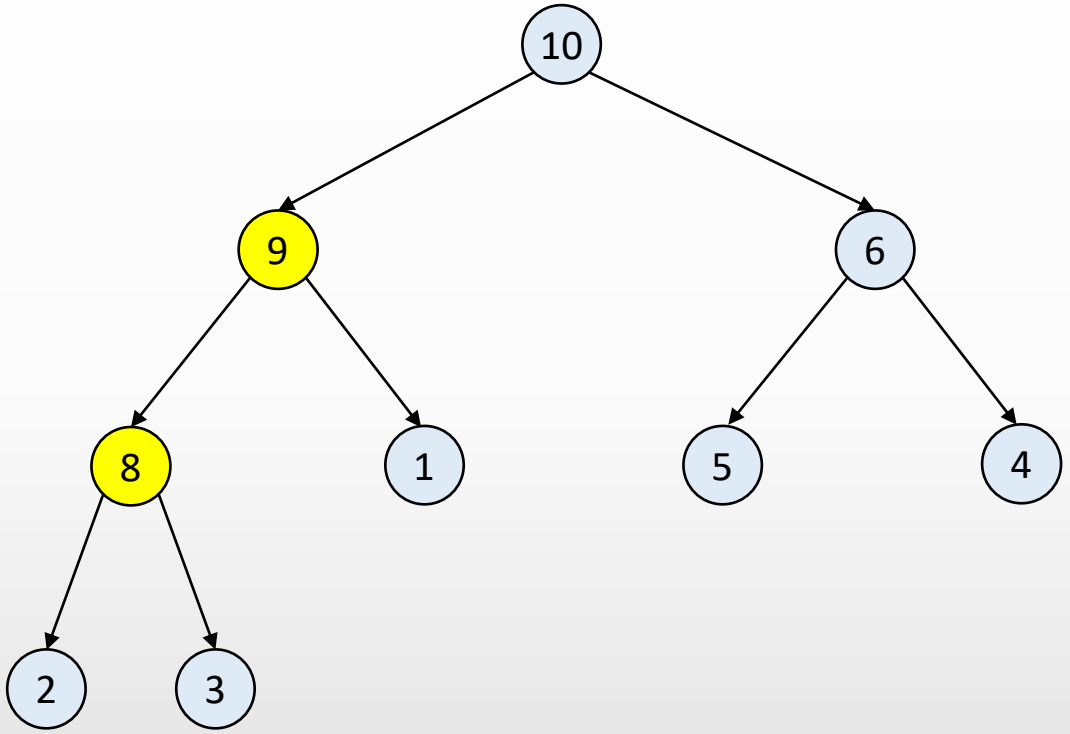

```
ekle(8)
```




```
ekle(8)
```




```
ekle(8)
```




```
ekle(8)
```

Sercan KÜLCÜ, Tüm hakları saklıdır.

Aşağıdan Yukarıya Heap Ağacına Dönüştürme

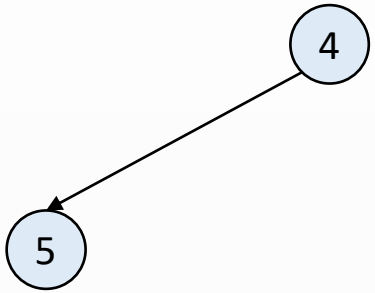
```
ekle(4)
```

4

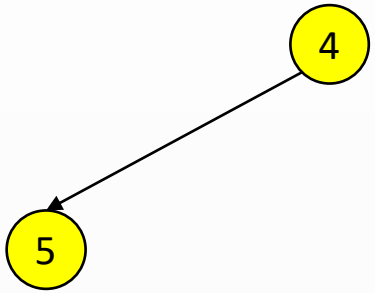
```
ekle(4)
```

4

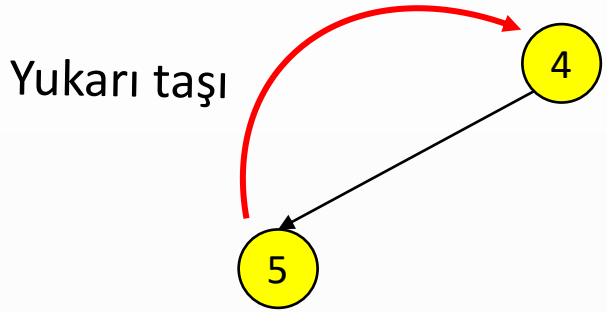
```
ekle(5)
```



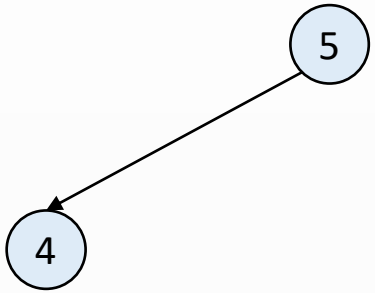

```
ekle(5)
```



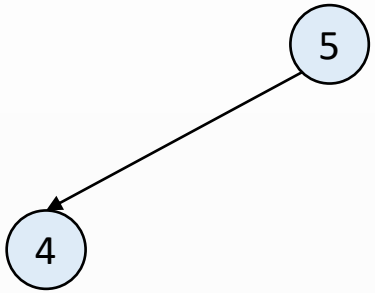

```
ekle(5)
```



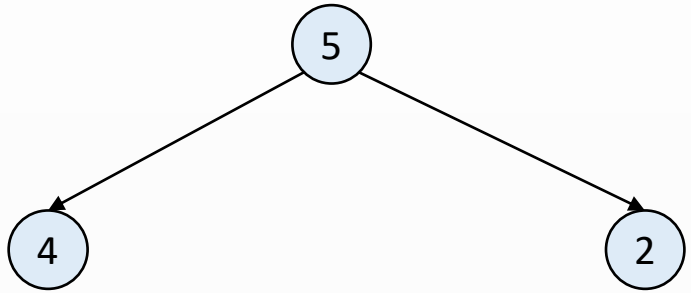

```
ekle(5)
```



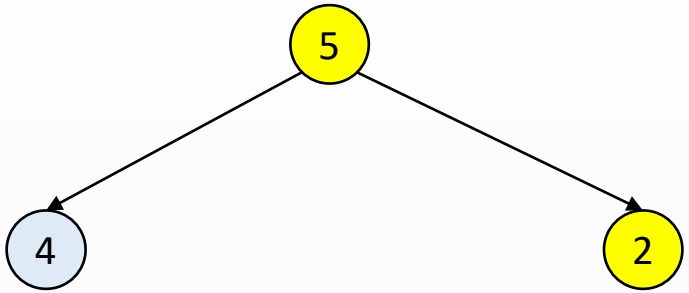

```
ekle(5)
```



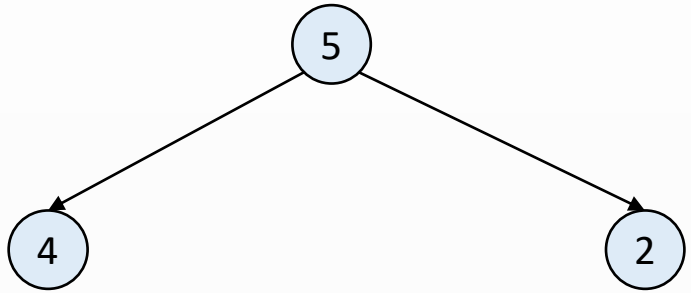

```
ekle(2)
```



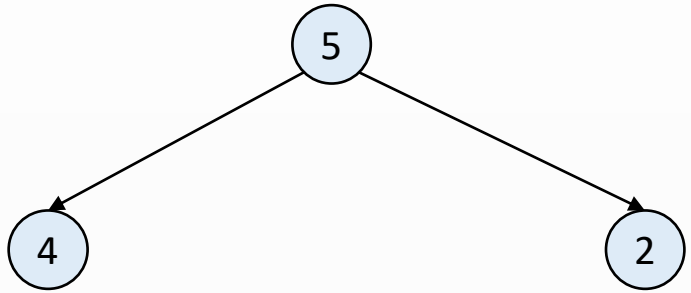

```
ekle(2)
```



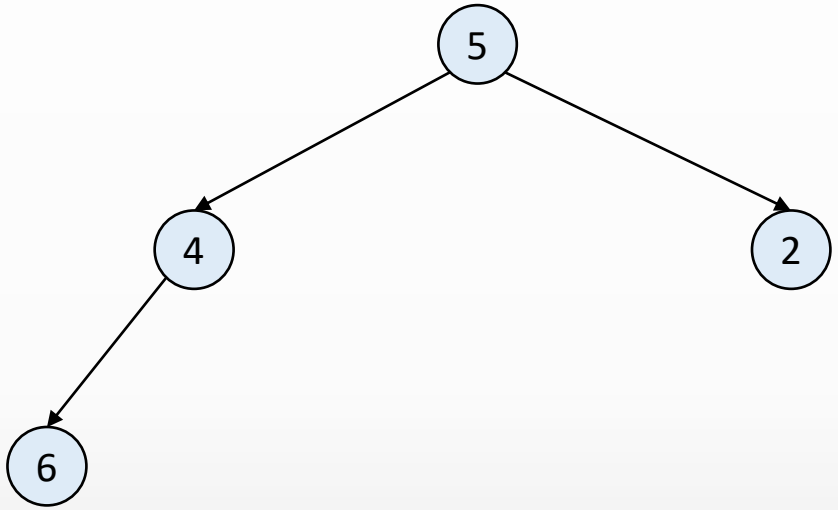

```
ekle(2)
```



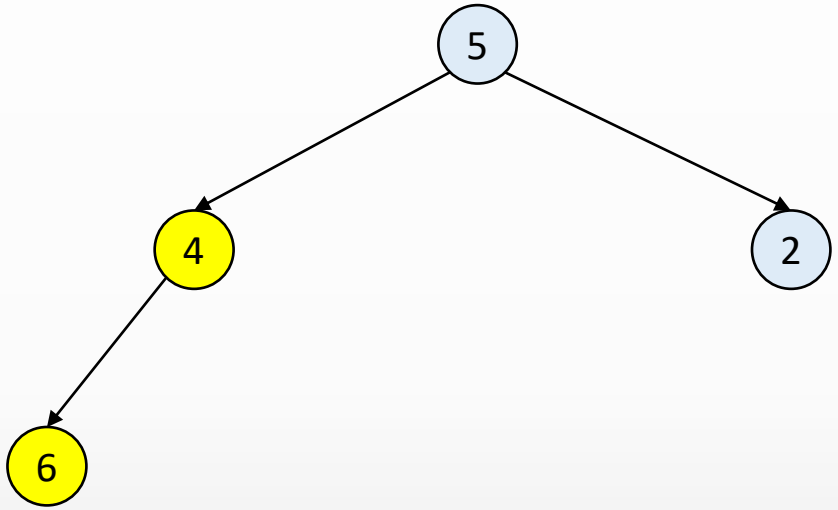

```
ekle(2)
```



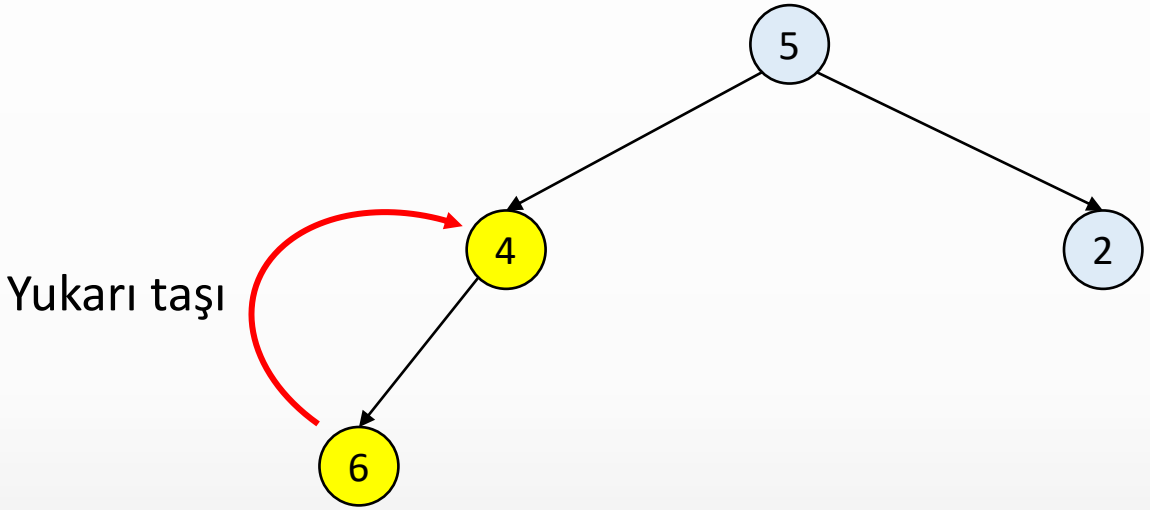

```
ekle(6)
```



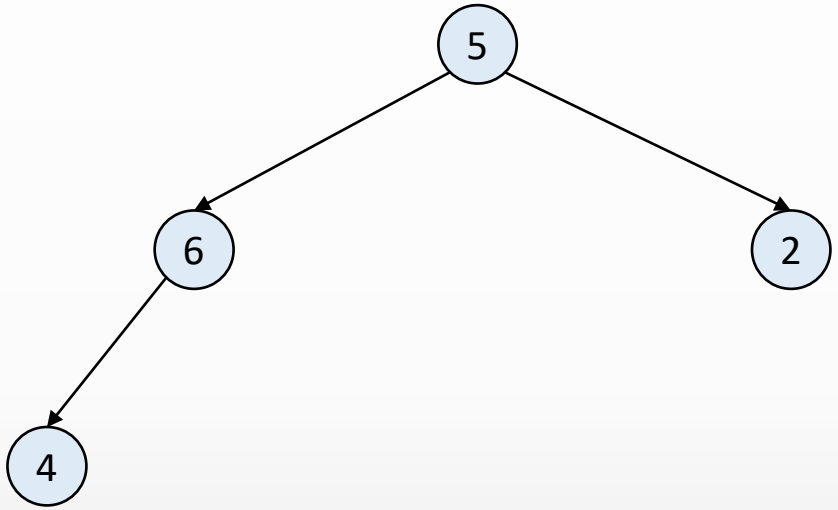

```
ekle(6)
```



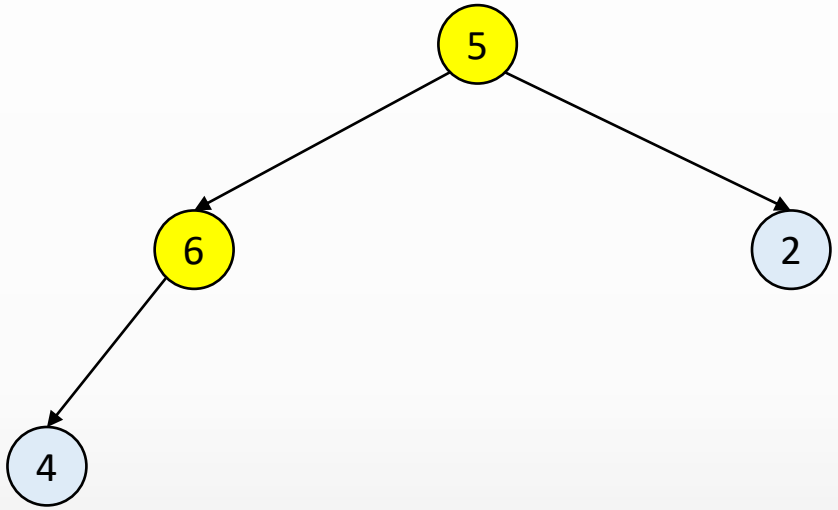

```
ekle(6)
```



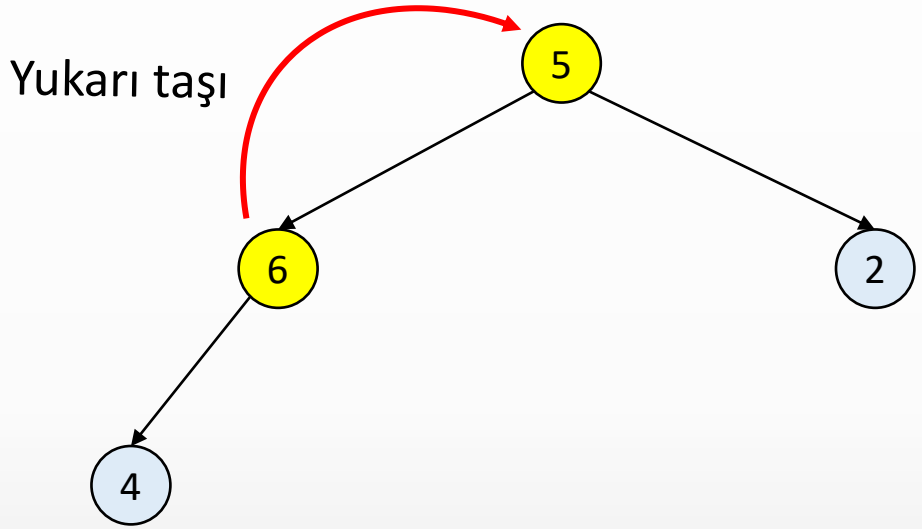

```
ekle(6)
```



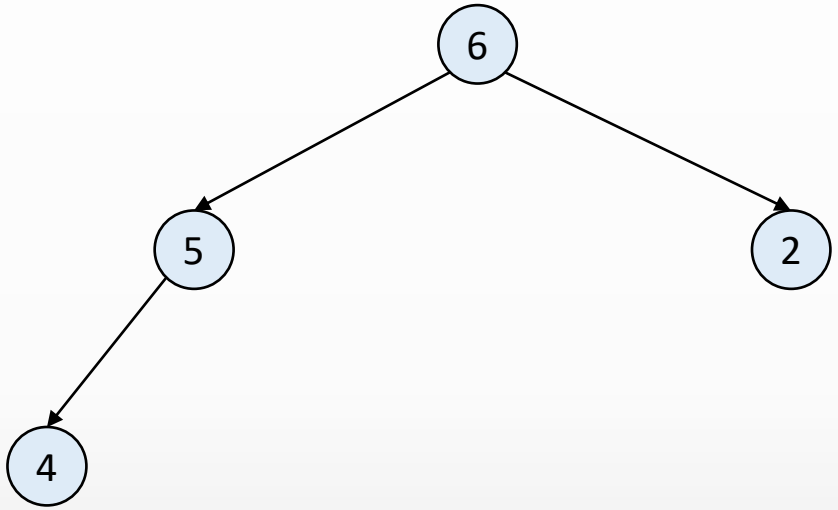

```
ekle(6)
```



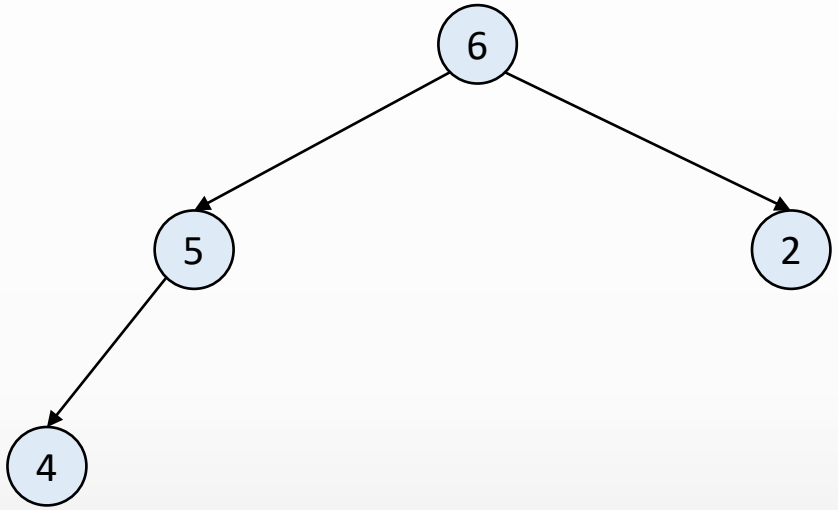

```
ekle(6)
```



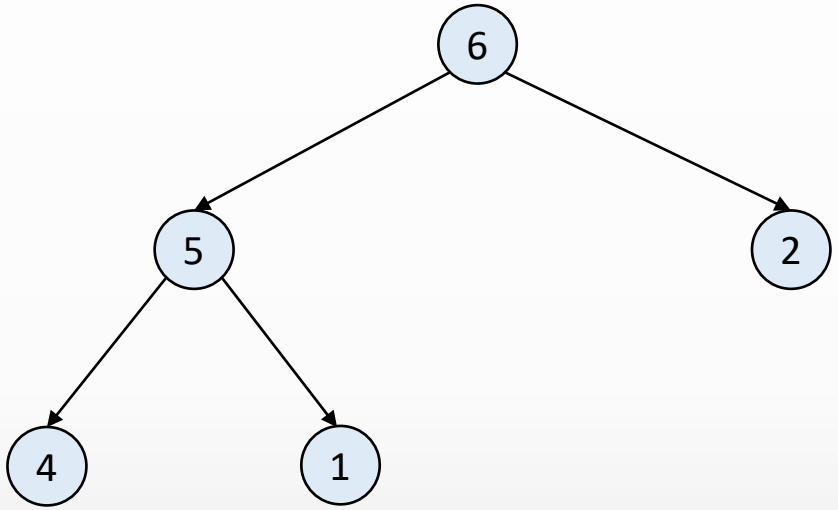

```
ekle(6)
```



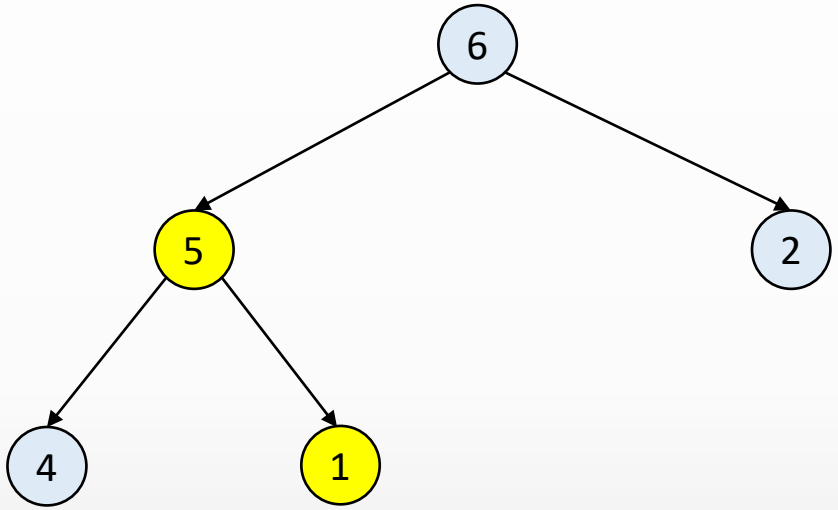

```
ekle(6)
```



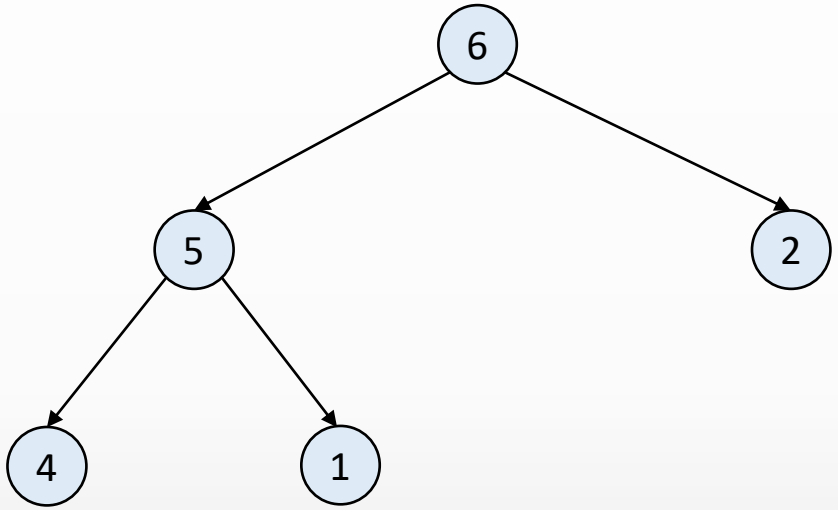

```
ekle(1)
```



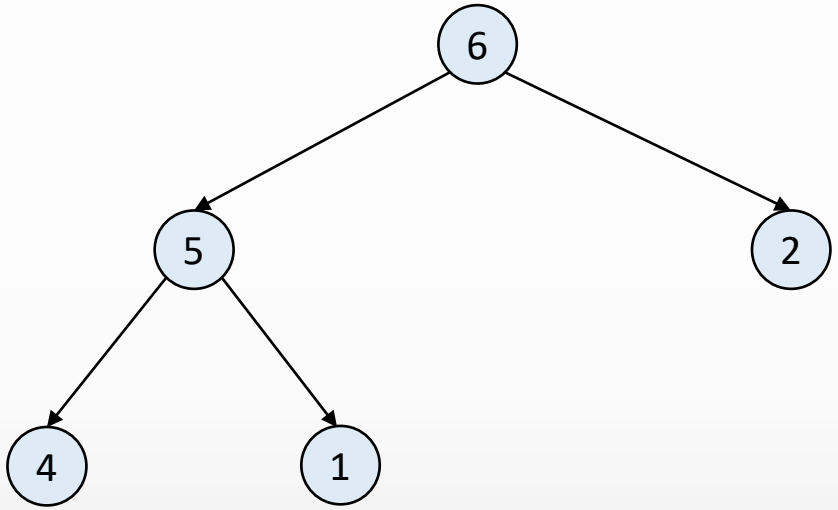

```
ekle(1)
```



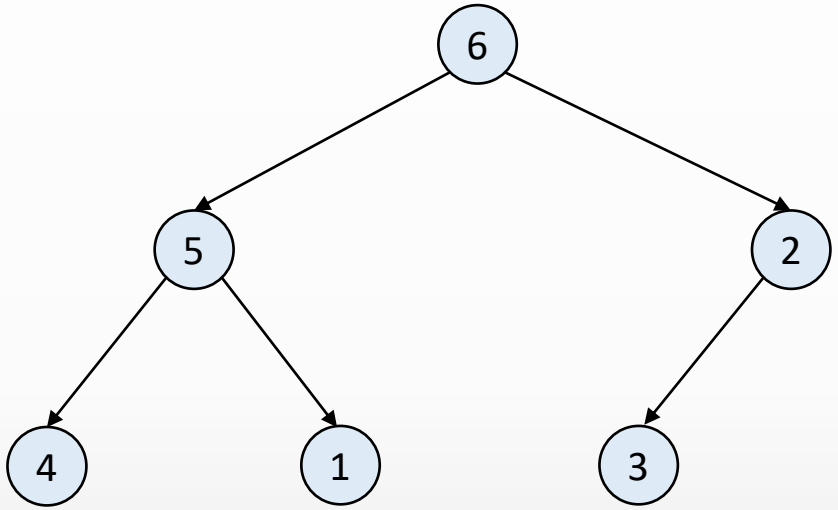

```
ekle(1)
```



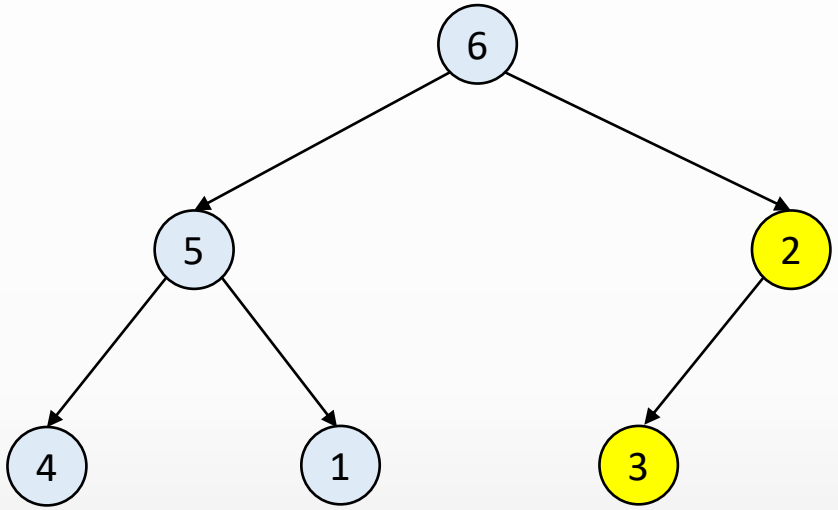

```
ekle(1)
```



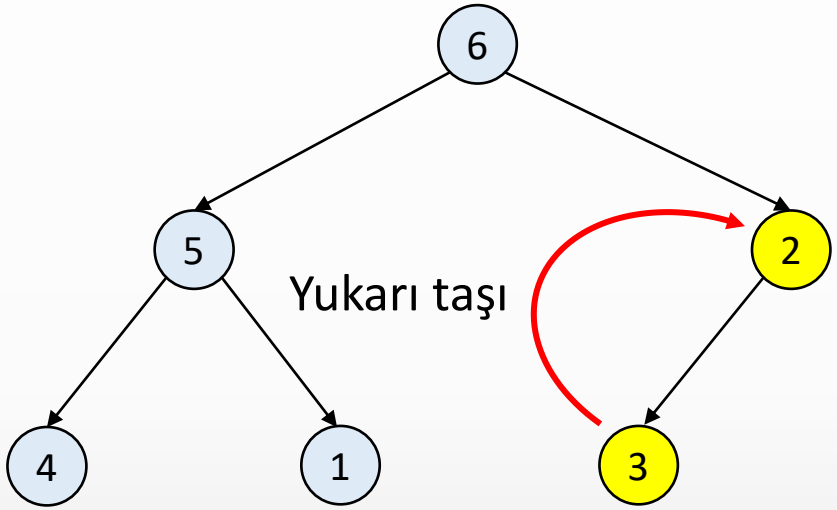

```
ekle(3)
```



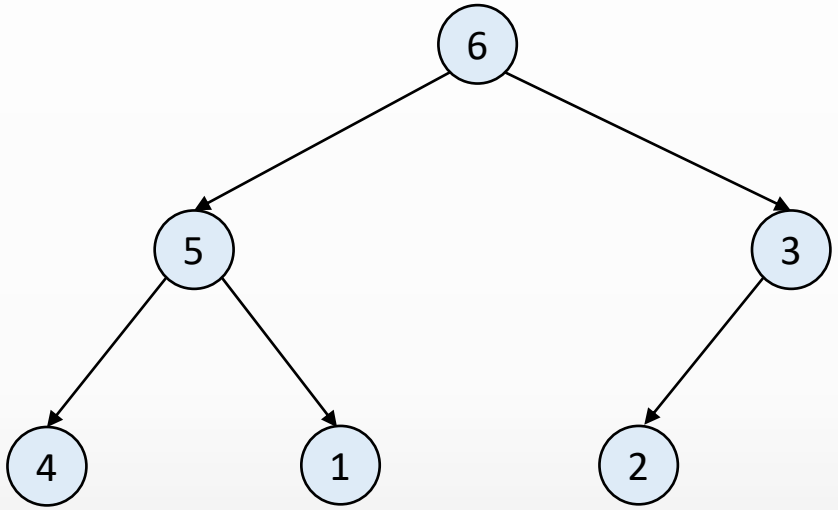

```
ekle(3)
```



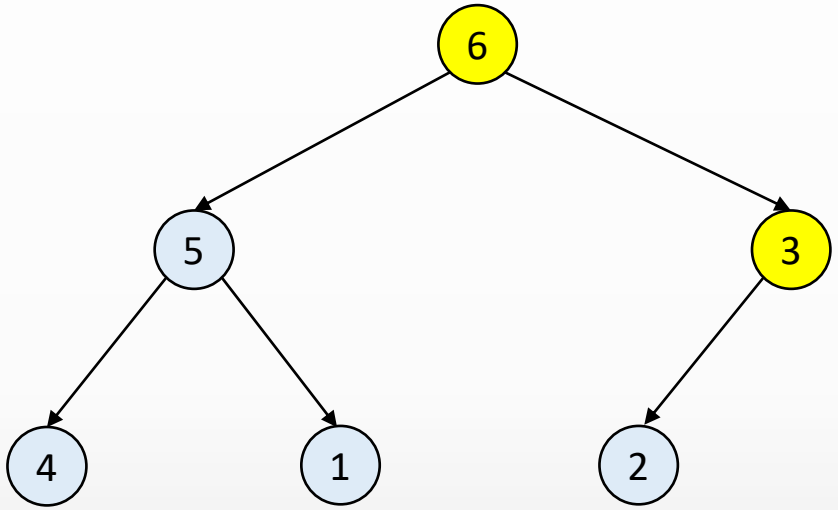

```
ekle(3)
```



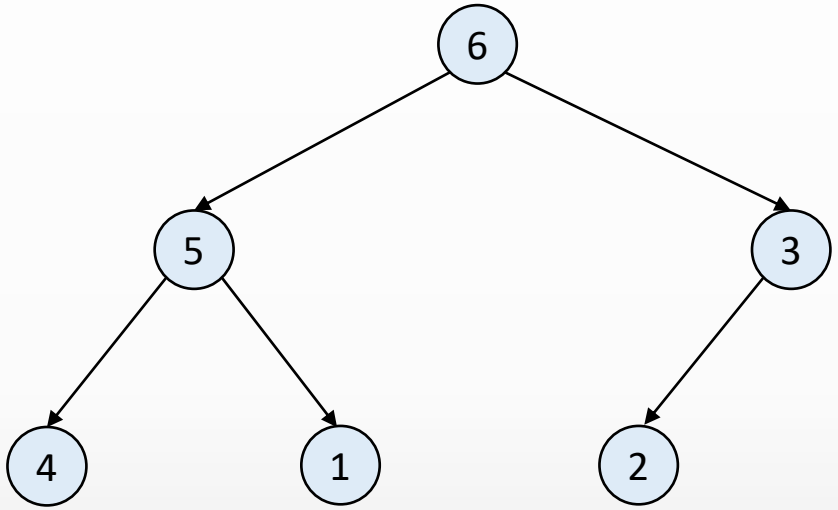

```
ekle(3)
```




```
ekle(3)
```




```
ekle(3)
```




```
ekle(3)
```

Sercan KÜLCÜ, Tüm hakları saklıdır.

Max Heap Ağacına Eleman Ekleme

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

Max Heap Ağacına Eleman Ekleme

```
MaxOK ok = new MaxOK(3);
```

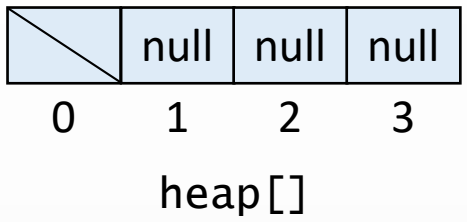
```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

null	null	null	null
0	1	2	3

heap[]

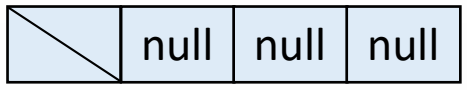
```
MaxOK ok = new MaxOK(3);
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
MaxOK ok = new MaxOK(3);
```

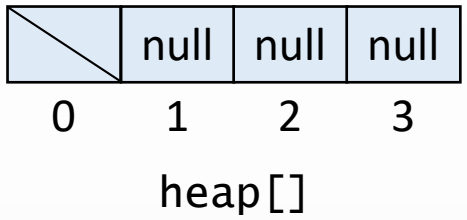
```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
heap.length = 4
```

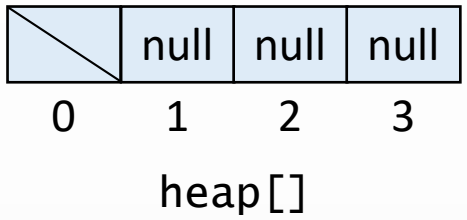
```
MaxOK ok = new MaxOK(3);
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



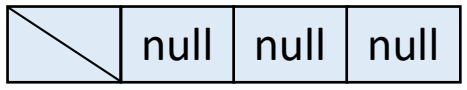
```
n = 0
heap.length = 4


MaxOK ok = new MaxOK(3);
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
n = 0
heap.length = 4


ekle(4)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
n = 0
heap.length = 4


ekle(4)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
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}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```
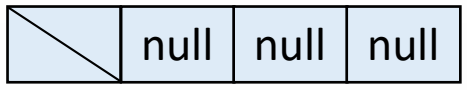
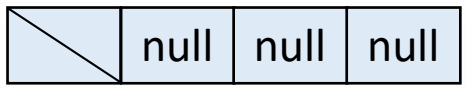



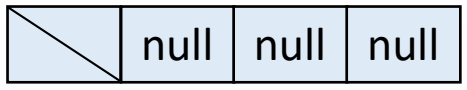
```
x = 4
n = 0
heap.length = 4


ekle(4)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



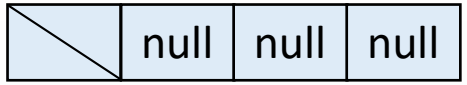
```
x = 4
n = 0
heap.length = 4


ekle(4)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
x = 4
n = 0
heap.length = 4


ekle(4)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```




```
x = 4
n = 1
heap.length = 4


ekle(4)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	4	null	null
0	1	2	3

heap[]

```
x = 4
n = 1
heap.length = 4


ekle(4)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	4	null	null
0	1	2	3

heap[]

```
x = 4
n = 1
heap.length = 4


ekle(4)
```



```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	4	null	null
0	1	2	3

heap[]

```
x = 4
n = 1
heap.length = 4


ekle(4)
```

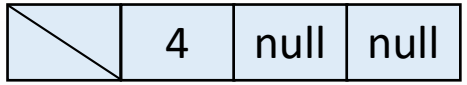
```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	4	null	null
0	1	2	3

heap[]

```
k = 1
x = 4
n = 1
heap.length = 4


ekle(4)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```




```
k = 1
x = 4
n = 1
heap.length = 4


ekle(4)
```

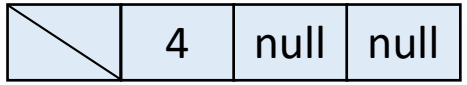
```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	4	null	null
0	1	2	3

heap[]

```
k = 1
x = 4
n = 1
heap.length = 4


ekle(4)
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```




```
k = 1
x = 4
n = 1
heap.length = 4


ekle(4)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	4	null	null
0	1	2	3

heap[]

```
x = 4
n = 1
heap.length = 4


ekle(4)
```



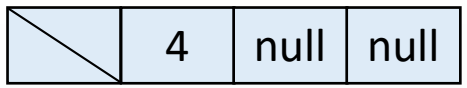
```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	4	null	null
0	1	2	3

heap[]

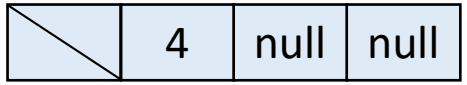
```
x = 4
n = 1
heap.length = 4


ekle(4)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



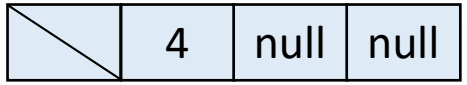
```
n = 1
heap.length = 4
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```




```
n = 1
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```




```
x = 5
n = 1
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	4	null	null
0	1	2	3

heap[]

```
x = 5
n = 1
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	4	null	null
0	1	2	3

heap[]

```
x = 5
n = 2
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
x = 5
n = 2
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
x = 5
n = 2
heap.length = 4


ekle(5)
```

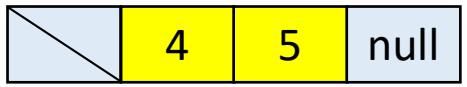
```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
k = 2
x = 5
n = 2
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
k = 2
x = 5
n = 2
heap.length = 4


ekle(5)
```

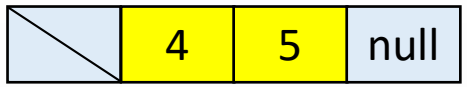
```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



heap[]

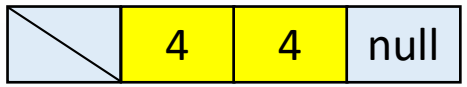
```
k/2 = 1
k = 2
x = 5
n = 2
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



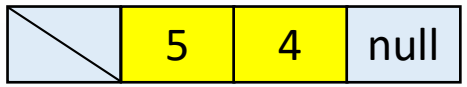
```
gecici = 5
k/2 = 1
k = 2
x = 5
n = 2
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



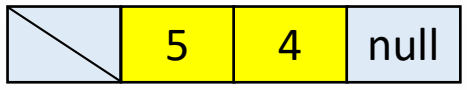
```
gecici = 5
k/2 = 1
k = 2
x = 5
n = 2
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



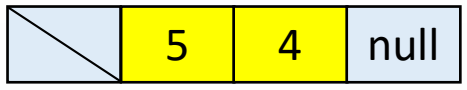
```
gecici = 5
k/2 = 1
k = 2
x = 5
n = 2
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
k = 1
x = 5
n = 2
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
k = 1
x = 5
n = 2
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

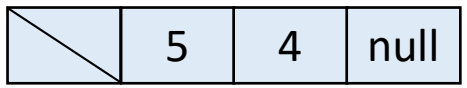
```
x = 5
n = 2
heap.length = 4


ekle(5)
```



```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

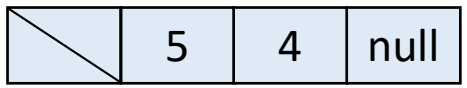
```
x = 5
n = 2
heap.length = 4


ekle(5)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
n = 2
heap.length = 4
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
n = 2
heap.length = 4


ekle(2)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
x = 2
n = 2
heap.length = 4


ekle(2)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
x = 2
n = 2
heap.length = 4


ekle(2)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
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  heap[n] = x;
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}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	4	null
0	1	2	3

heap[]

```
x = 2
n = 3
heap.length = 4


ekle(2)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
x = 2
n = 3
heap.length = 4


ekle(2)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
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  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
x = 2
n = 3
heap.length = 4


ekle(2)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
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    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
x = 2
n = 3
heap.length = 4


ekle(2)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
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    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	4	2
0	1	2	3

heap[]

k = 3
x = 2
n = 3
heap.length = 4

ekle(2)

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
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    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	4	2
0	1	2	3

heap[]

```
k = 3
x = 2
n = 3
heap.length = 4


ekle(2)
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
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  while (k > 1 && heap[k / 2] < heap[k]) {
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    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
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```

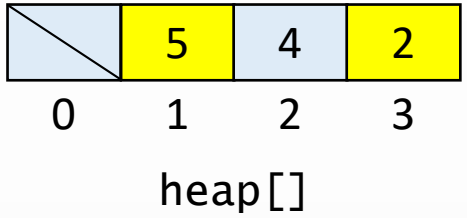

```
k/2 = 1
k = 3
x = 2
n = 3
heap.length = 4


ekle(2)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
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}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

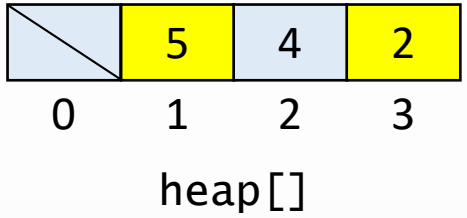

```
k/2 = 1
k = 3
x = 2
n = 3
heap.length = 4


ekle(2)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
x = 2
n = 3
heap.length = 4


ekle(2)
```



```java
public void ekle(int x) {
  if (n == heap.length - 1) {
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  }
  n++;
  heap[n] = x;
  yuzdur(n);
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    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
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```
x = 2
n = 3
heap.length = 4


ekle(2)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
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  n++;
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  yuzdur(n);
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private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```
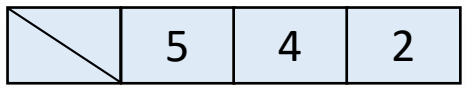



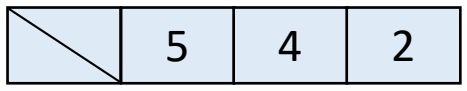
```
n = 3
heap.length = 4
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

n = 3
heap.length = 4

ekle(6)

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
x = 6
n = 3
heap.length = 4


ekle(6)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

```
x = 6
n = 3
heap.length = 4


ekle(6)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
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  heap[n] = x;
  yuzdur(n);
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  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

x = 6
n = 3
heap.length = 4

ekle(6)

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	4	2	null	null	null	null
0	1	2	3	4	5	6	7

heap[]

```
x = 6
n = 3
heap.length = 8


ekle(6)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	4	2	null	null	null	null
0	1	2	3	4	5	6	7

heap[]

```
x = 6
n = 4
heap.length = 8


ekle(6)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	4	2	6	null	null	null
0	1	2	3	4	5	6	7

heap[]

```
x = 6
n = 4
heap.length = 8


ekle(6)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	4	2	6	null	null	null
0	1	2	3	4	5	6	7

heap[]

```
x = 6
n = 4
heap.length = 8


ekle(6)
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	4	2	6	null	null	null
0	1	2	3	4	5	6	7

heap[]

```
x = 6
n = 4
heap.length = 8


ekle(6)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	4	2	6	null	null	null
0	1	2	3	4	5	6	7

heap[]

```
k = 4
x = 6
n = 4
heap.length = 8


ekle(6)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	4	2	6	null	null	null
0	1	2	3	4	5	6	7

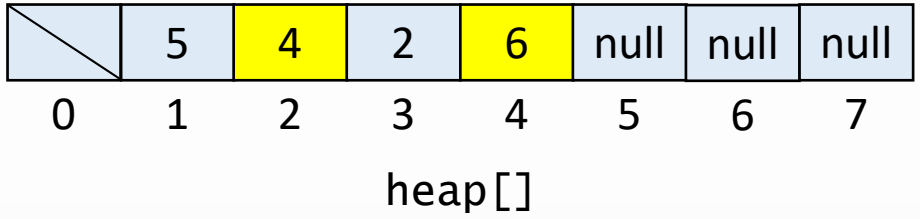
heap[]

k/2 = 2
k = 4
x = 6
n = 4
heap.length = 8

ekle(6)

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```




```
k/2 = 2
k = 4
x = 6
n = 4
heap.length = 8


ekle(6)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
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    int gecici = heap[k];
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    k = k / 2;
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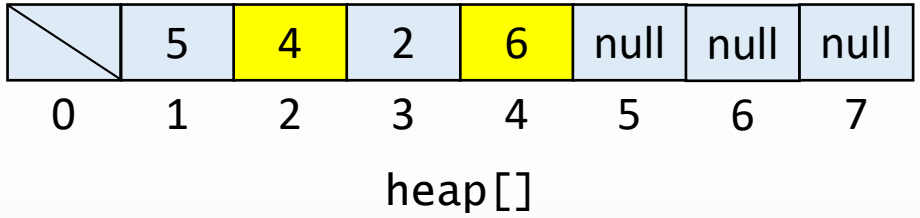
}
```



```
gecici = 6
k/2 = 2
k = 4
x = 6
n = 4
heap.length = 8


ekle(6)
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
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  }
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  heap[n] = x;
  yuzdur(n);
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    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
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}
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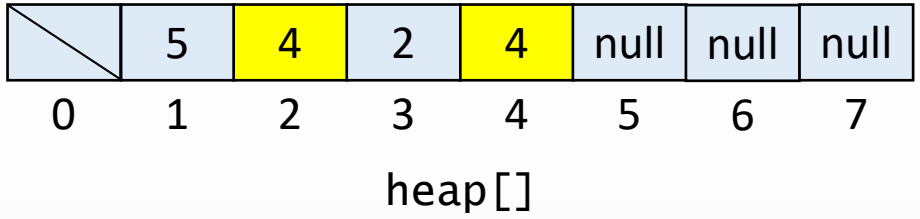

```
gecici = 6
k/2 = 2
k = 4
x = 6
n = 4
heap.length = 8


ekle(6)
```



```java
public void ekle(int x) {
  if (n == heap.length - 1) {
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    int gecici = heap[k];
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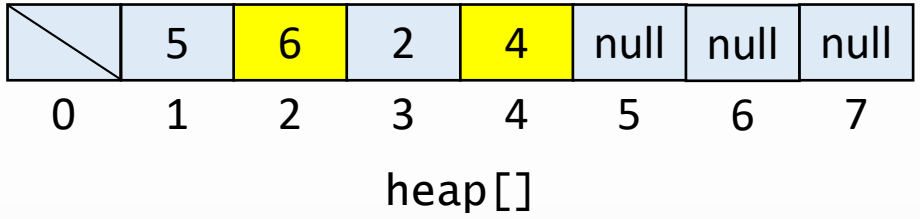
```



```
gecici = 6
k/2 = 2
k = 4
x = 6
n = 4
heap.length = 8


ekle(6)
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
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  }
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    k = k / 2;
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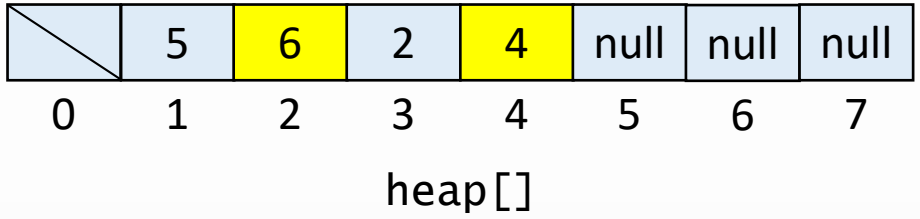
}
```




```
gecici = 6
k/2 = 2
k = 2
x = 6
n = 4
heap.length = 8


ekle(6)
```

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public void ekle(int x) {
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    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	6	2	4	null	null	null
0	1	2	3	4	5	6	7

heap[]

```
k = 2
x = 6
n = 4
heap.length = 8


ekle(6)
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
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  yuzdur(n);
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private void yuzdur(int k) {
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    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	5	6	2	4	null	null	null
0	1	2	3	4	5	6	7

heap[]

```
k/2 = 1
k = 2
x = 6
n = 4
heap.length = 8


ekle(6)
```

```java
public void ekle(int x) {
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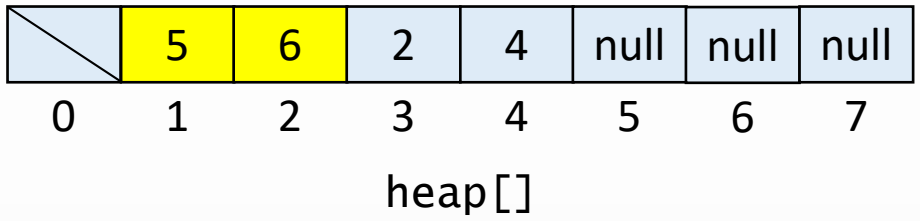
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

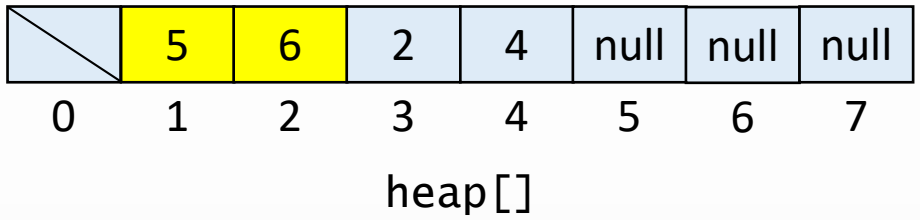


```
k/2 = 1
k = 2
x = 6
n = 4
heap.length = 8


ekle(6)
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
gecici = 6
k/2 = 1
k = 2
x = 6
n = 4
heap.length = 8


ekle(6)
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
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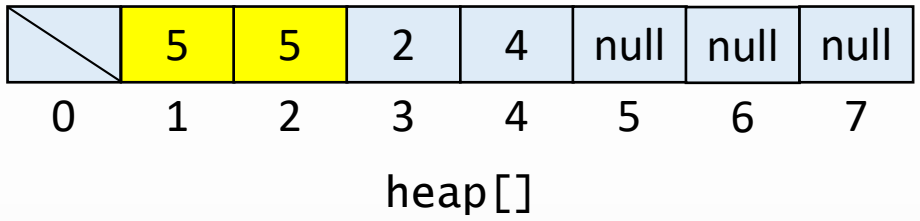
}
```




```
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ekle(6)
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    k = k / 2;
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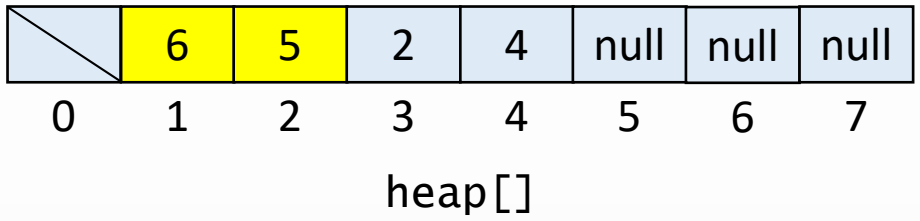


```
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k/2 = 1
k = 2
x = 6
n = 4
heap.length = 8


ekle(6)
```

```java
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    k = k / 2;
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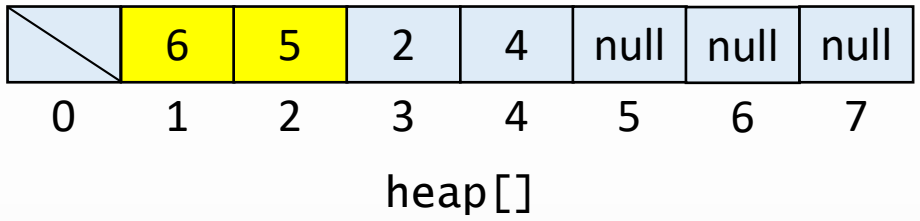
}
```



```
gecici = 6
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ekle(6)
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```java
public void ekle(int x) {
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    k = k / 2;
  }
}
```

	6	5	2	4	null	null	null
0	1	2	3	4	5	6	7

heap[]

```
k = 1
x = 6
n = 4
heap.length = 8


ekle(6)
```

```
public void ekle(int x) {
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    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	6	5	2	4	null	null	null
0	1	2	3	4	5	6	7

heap[]

```
k = 1
x = 6
n = 4
heap.length = 8


ekle(6)
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
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```

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0	1	2	3	4	5	6	7

heap[]

```
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n = 4
heap.length = 8


ekle(6)
```

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heap[]

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ekle(6)
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    heap[k / 2] = gecici;
    k = k / 2;
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}
```

n = 4
heap.length = 8

```
public void ekle(int x) {
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```

	6	5	2	4	null	null	null
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heap[]

```
n = 4
heap.length = 8


ekle(1)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
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    int gecici = heap[k];
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```

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heap[]

```
x = 1
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heap.length = 8


ekle(1)
```

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public void ekle(int x) {
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heap[]

```
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ekle(1)
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heap[]

```
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ekle(1)
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ekle(1)
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ekle(1)
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heap[]

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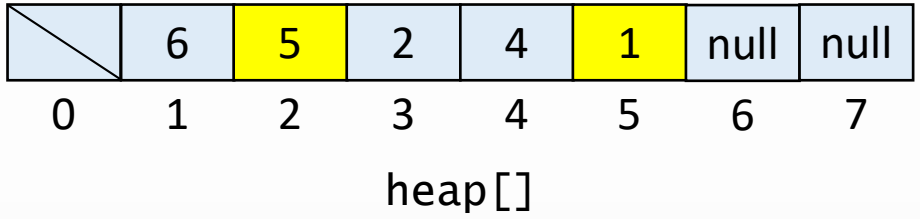

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ekle(1)

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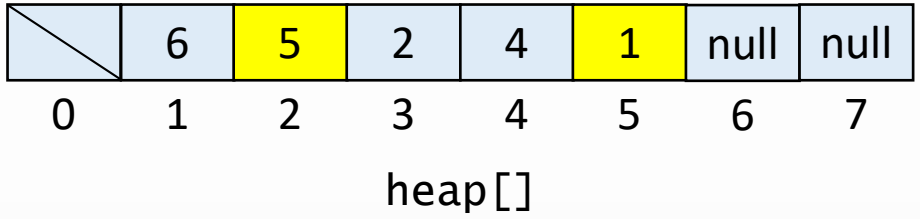


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ekle(1)
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heap[]

```
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ekle(1)
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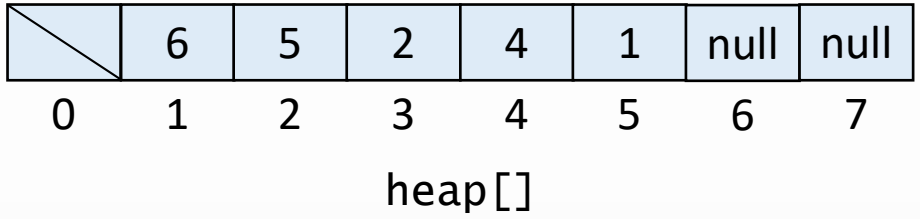


```
n = 5
heap.length = 8
```

```java
public void ekle(int x) {
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```

	6	5	2	4	1	null	null
0	1	2	3	4	5	6	7

heap[]

```
x = 3
n = 5
heap.length = 8


ekle(3)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
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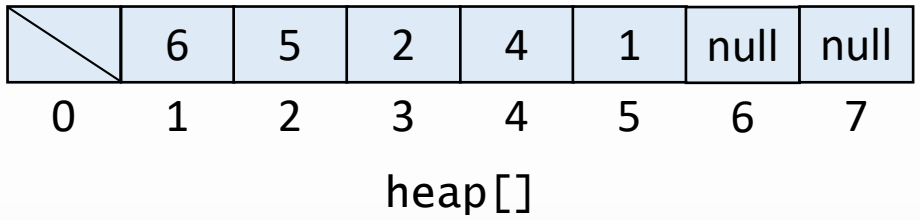


```
x = 3
n = 5
heap.length = 8


ekle(3)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
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    k = k / 2;
  }
}
```

	6	5	2	4	1	null	null
0	1	2	3	4	5	6	7

heap[]

```
x = 3
n = 6
heap.length = 8


ekle(3)
```

```java
public void ekle(int x) {
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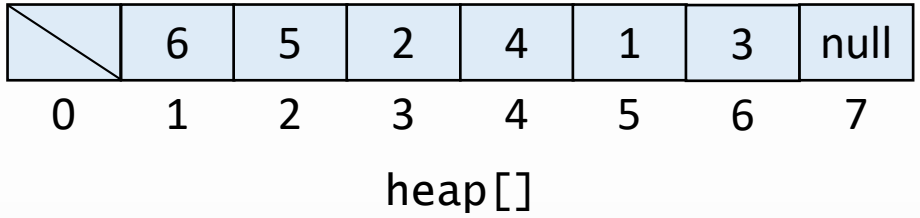


```
x = 3
n = 6
heap.length = 8


ekle(3)
```

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	6	5	2	4	1	3	null
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heap[]

```
x = 3
n = 6
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ekle(3)
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    k = k / 2;
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0	1	2	3	4	5	6	7

heap[]

```
k = 6
x = 3
n = 6
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ekle(3)
```

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public void ekle(int x) {
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	6	5	2	4	1	3	null
0	1	2	3	4	5	6	7

heap[]

```
k/2 = 3
k = 6
x = 3
n = 6
heap.length = 8


ekle(3)
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```java
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}
```
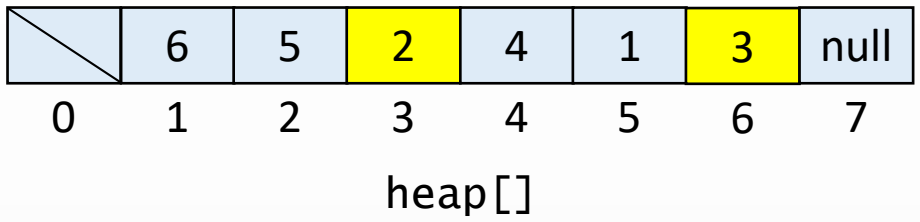
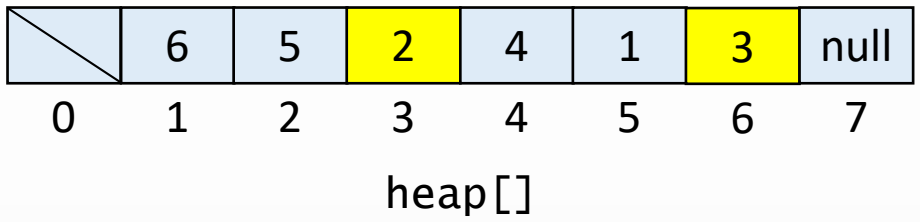



```
k/2 = 3
k = 6
x = 3
n = 6
heap.length = 8


ekle(3)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
}

private void yuzdur(int k) {
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
gecici = 3
k/2 = 3
k = 6
x = 3
n = 6
heap.length = 8


ekle(3)
```

```java
public void ekle(int x) {
  if (n == heap.length - 1) {
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  }
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    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

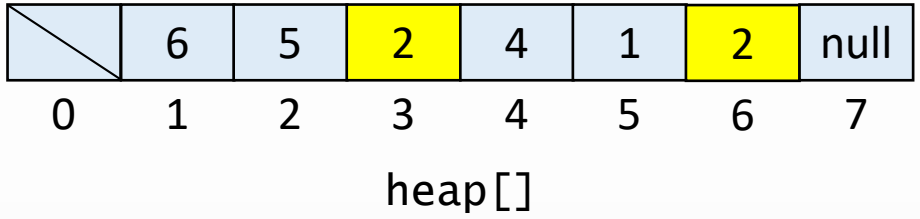

```
gecici = 3
k/2 = 3
k = 6
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n = 6
heap.length = 8


ekle(3)
```



```java
public void ekle(int x) {
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  yuzdur(n);
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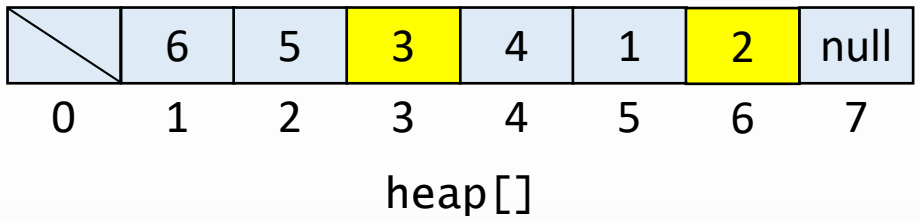
  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



```
gecici = 3
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    heap[k] = heap[k / 2];
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```

```
gecici = 3
k/2 = 3
k = 3
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```java
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    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	6	5	3	4	1	2	null
0	1	2	3	4	5	6	7

heap[]

```
k = 3
x = 3
n = 6
heap.length = 8


ekle(3)
```

```
public void ekle(int x) {
  if (n == heap.length - 1) {
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  n++;
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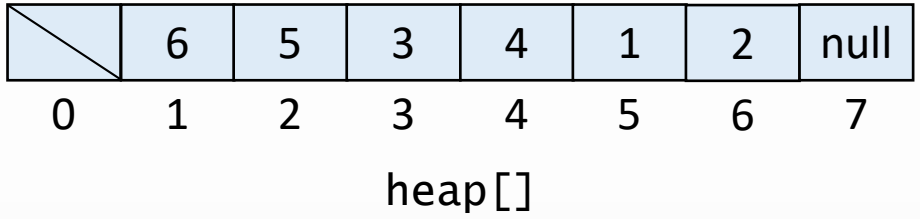
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```




```
k/2 = 1
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ekle(3)
```

```
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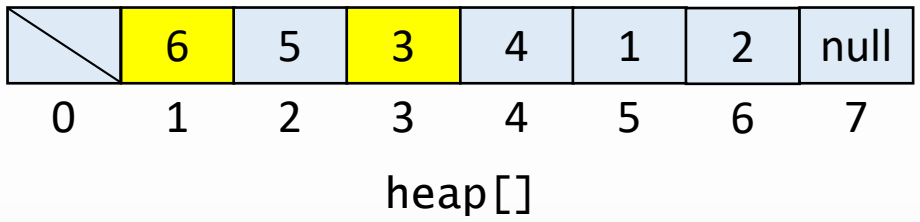
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



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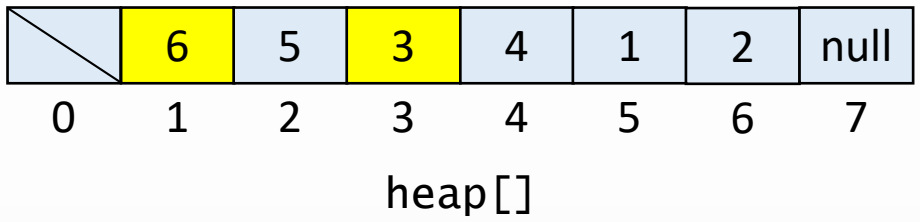
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



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ekle(3)
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```java
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    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

	6	5	3	4	1	2	null
0	1	2	3	4	5	6	7

heap[]

```
x = 3
n = 6
heap.length = 8


ekle(3)
```

```java
public void ekle(int x) {
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    k = k / 2;
  }
}
```

	6	5	3	4	1	2	null
0	1	2	3	4	5	6	7

heap[]

```
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n = 6
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public void ekle(int x) {
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  n++;
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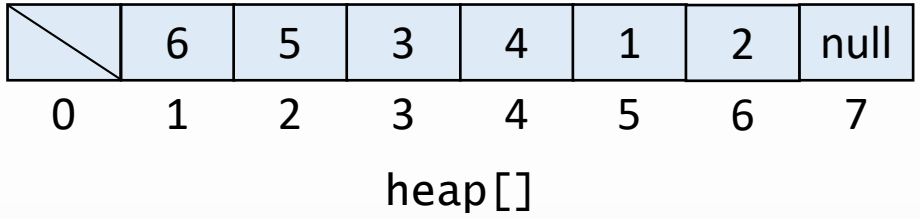
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```



n = 6
heap.length = 8

```
public void ekle(int x) {
  if (n == heap.length - 1) {
    buyut(2 * heap.length);
  }
  n++;
  heap[n] = x;
  yuzdur(n);
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  while (k > 1 && heap[k / 2] < heap[k]) {
    int gecici = heap[k];
    heap[k] = heap[k / 2];
    heap[k / 2] = gecici;
    k = k / 2;
  }
}
```

Yukarıdan Aşağıya Heap Ağacına Dönüştürme

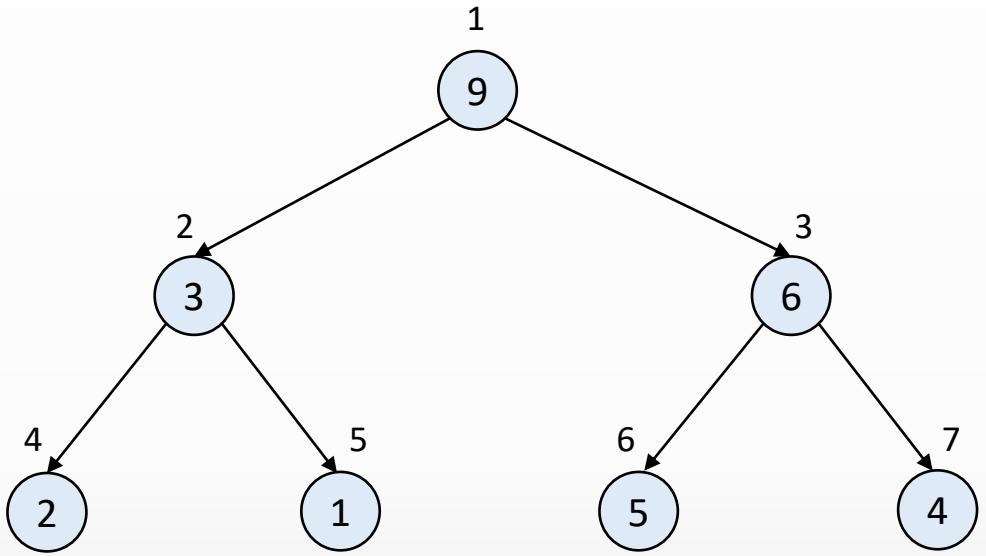
Sercan KÜLCÜ, Tüm hakları saklıdır.

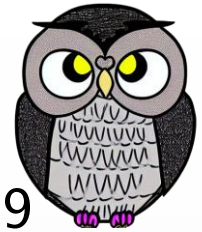
Yukarıdan Aşağıya Heap Ağacına Dönüştürme

- Max heap ikili ağacının her bir düğümünün değeri, çocuklarının değerlerinden büyüktür.
- Heap ağacından bir öğe çıkarıldıktan sonra bu özellik bozulabilir.
- Bu nedenle öğelerin yerlerinin değiştirilmesi gerekir.
- Ağaç yukarıdan aşağıya doğru taranarak yeniden heap ağacına dönüştürme işlemi (batır - sink) uygulanır (top-down heapify).

Sercan KÜLCÜ, Tüm hakları saklıdır.

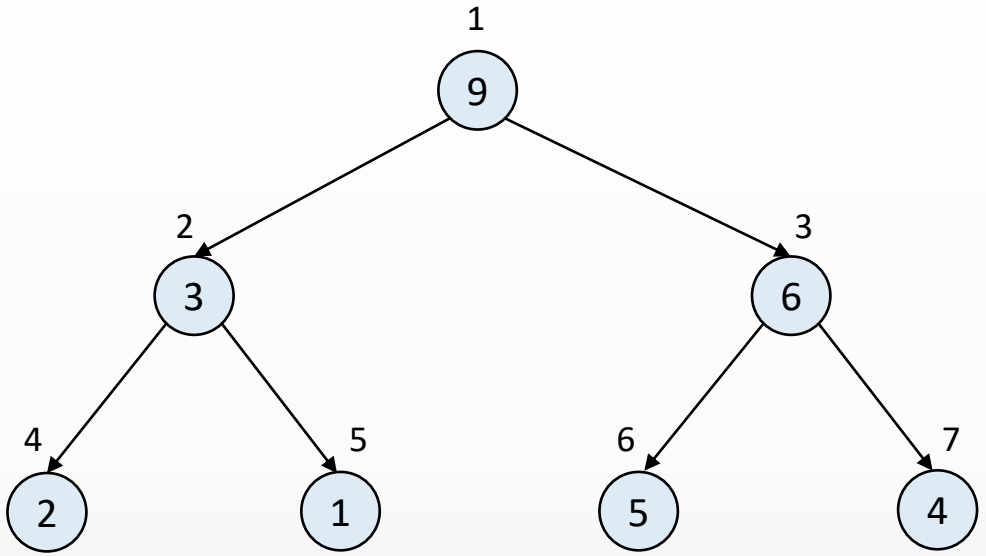
silMax()

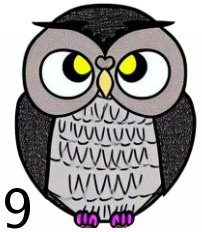




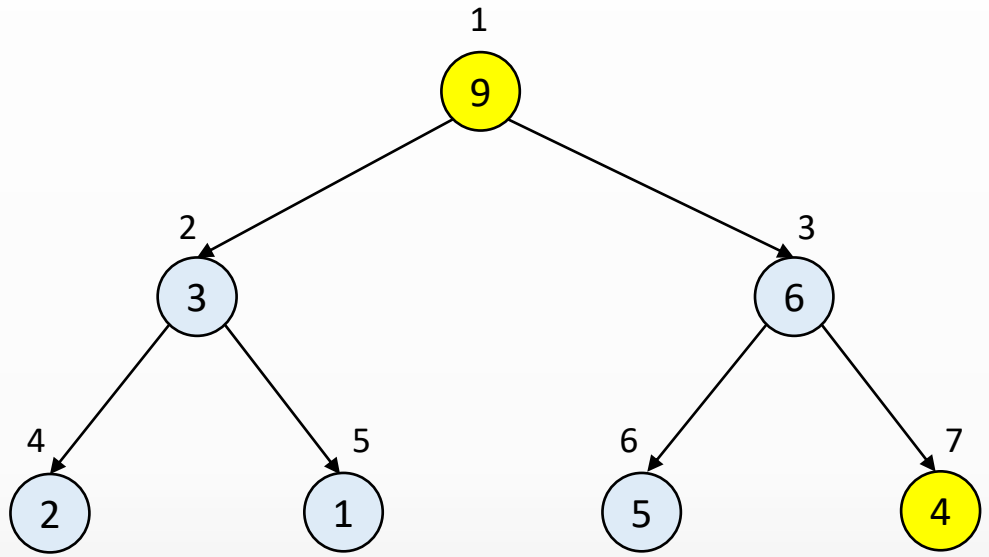
```
silMax()
```

max = 9



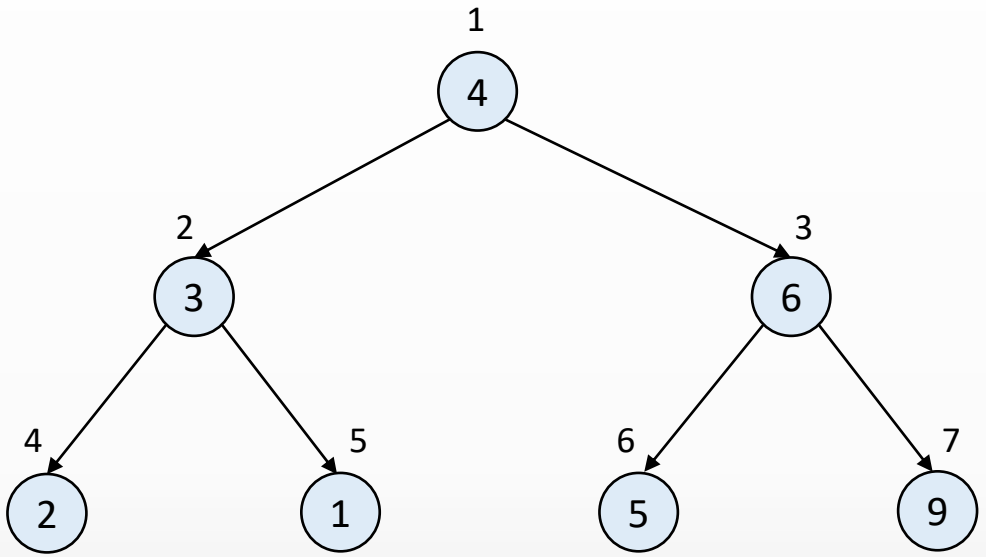


```
silMax()
```

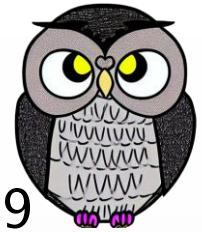



```
max = 9
```

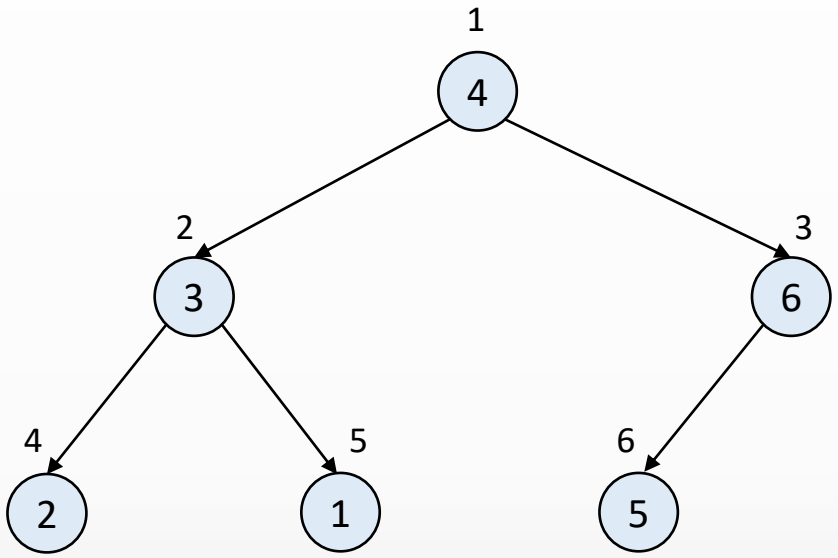
silMax()



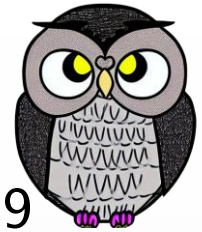
max = 9



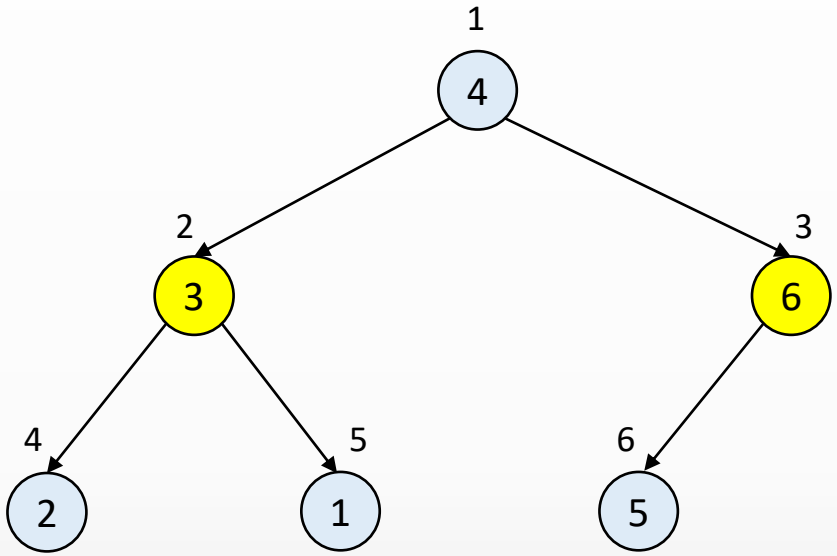
silMax()



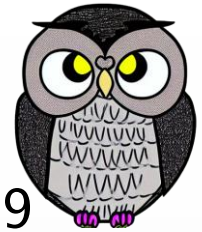
max = 9



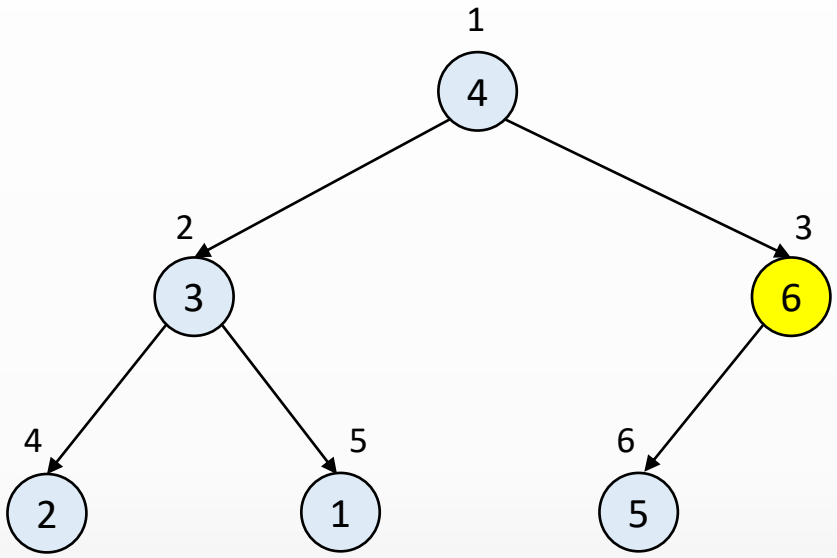
```
silMax()
```



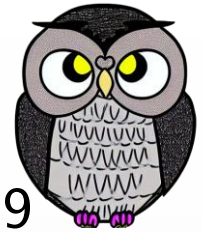

```
max = 9
```



silMax()

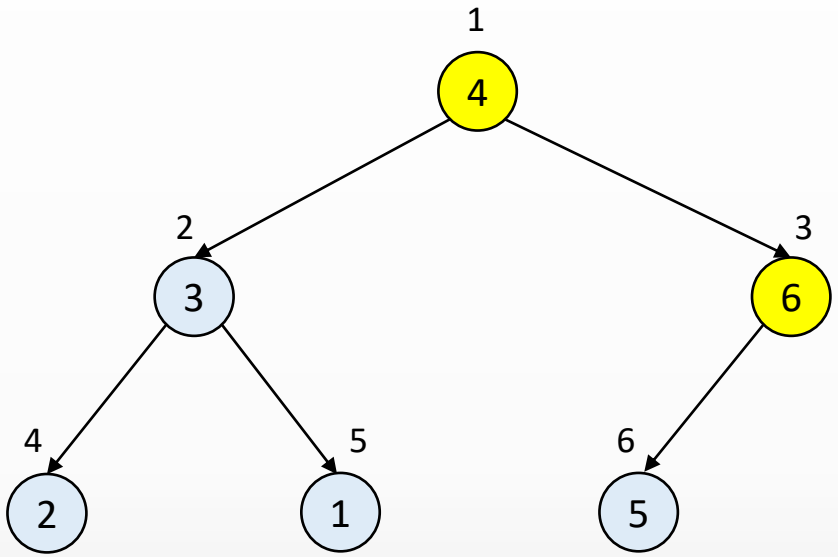


max = 9

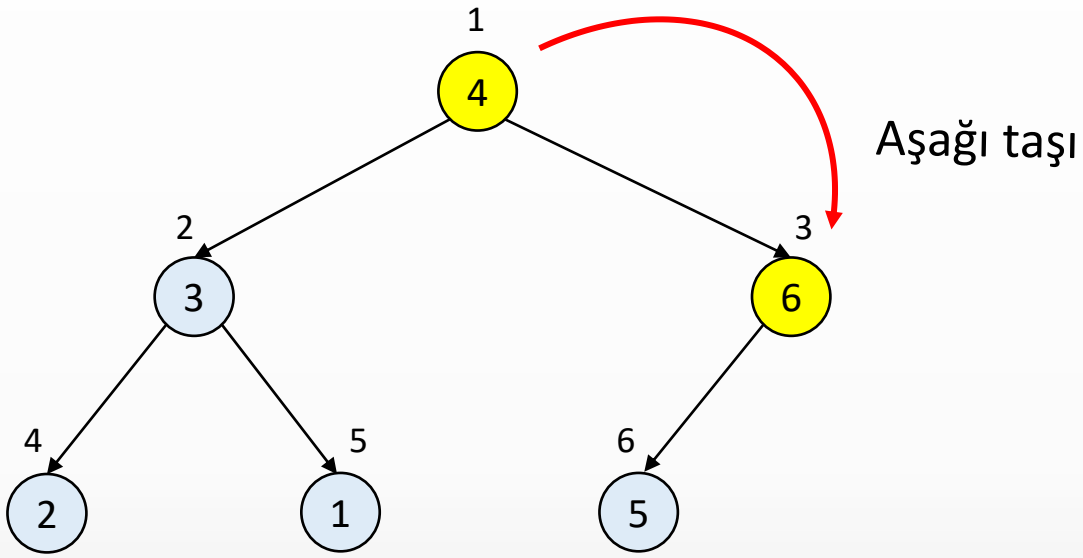


silMax()

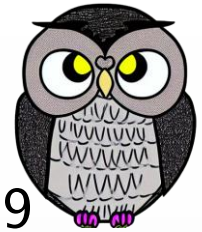
max = 9

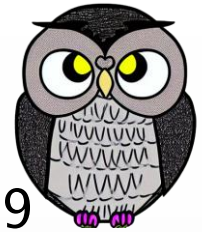


silMax()

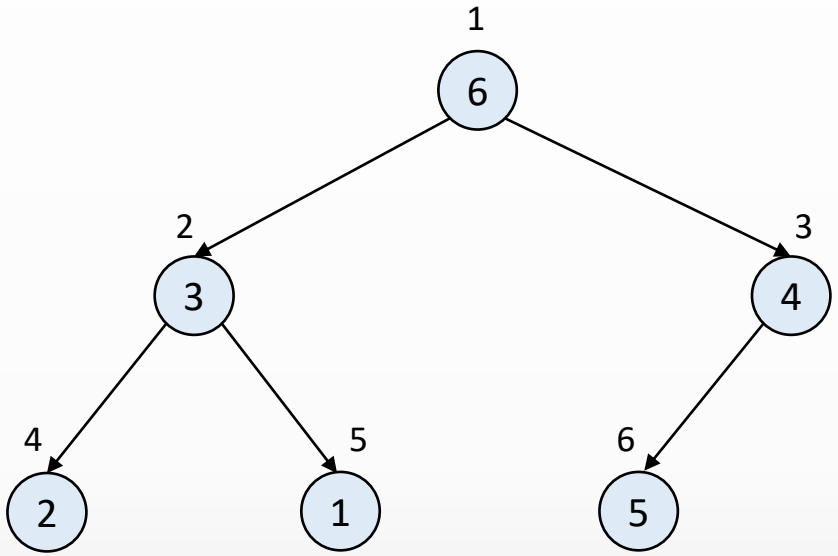


max = 9



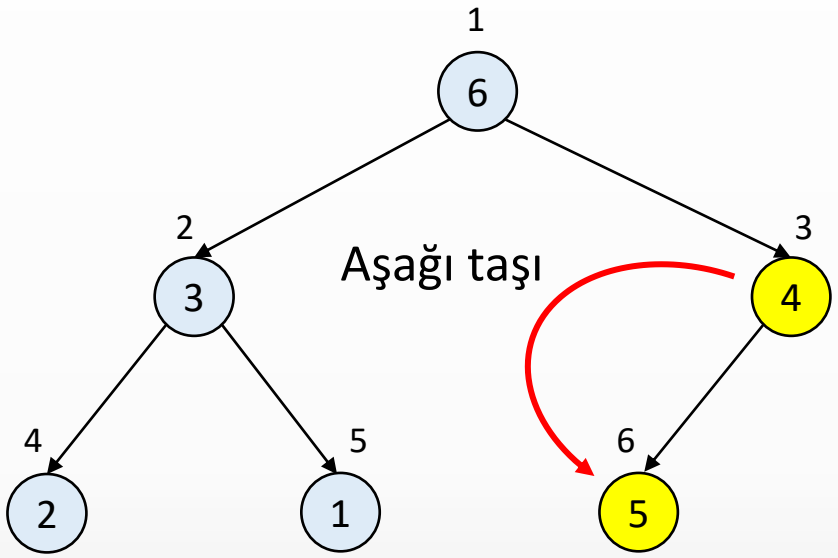


```
silMax()
```

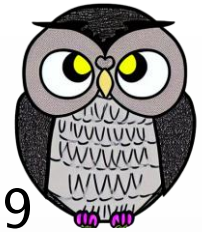


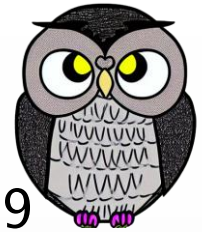

```
max = 9
```

silMax()

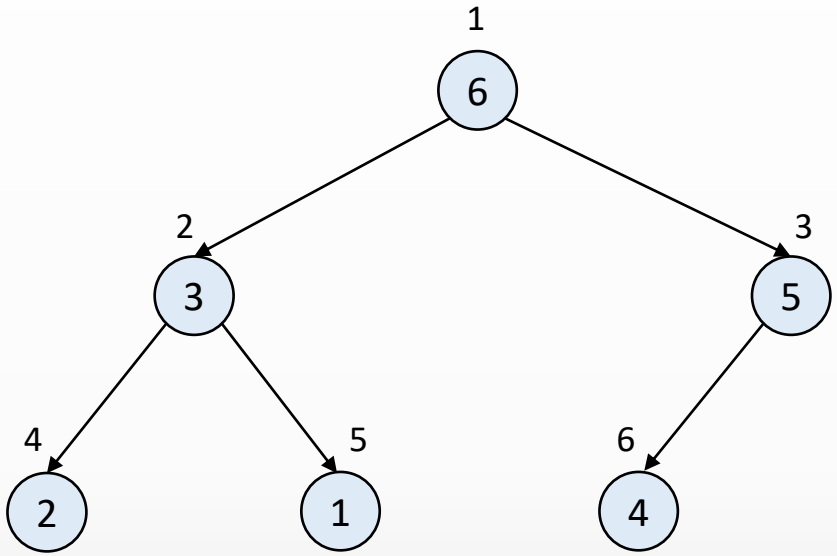


max = 9





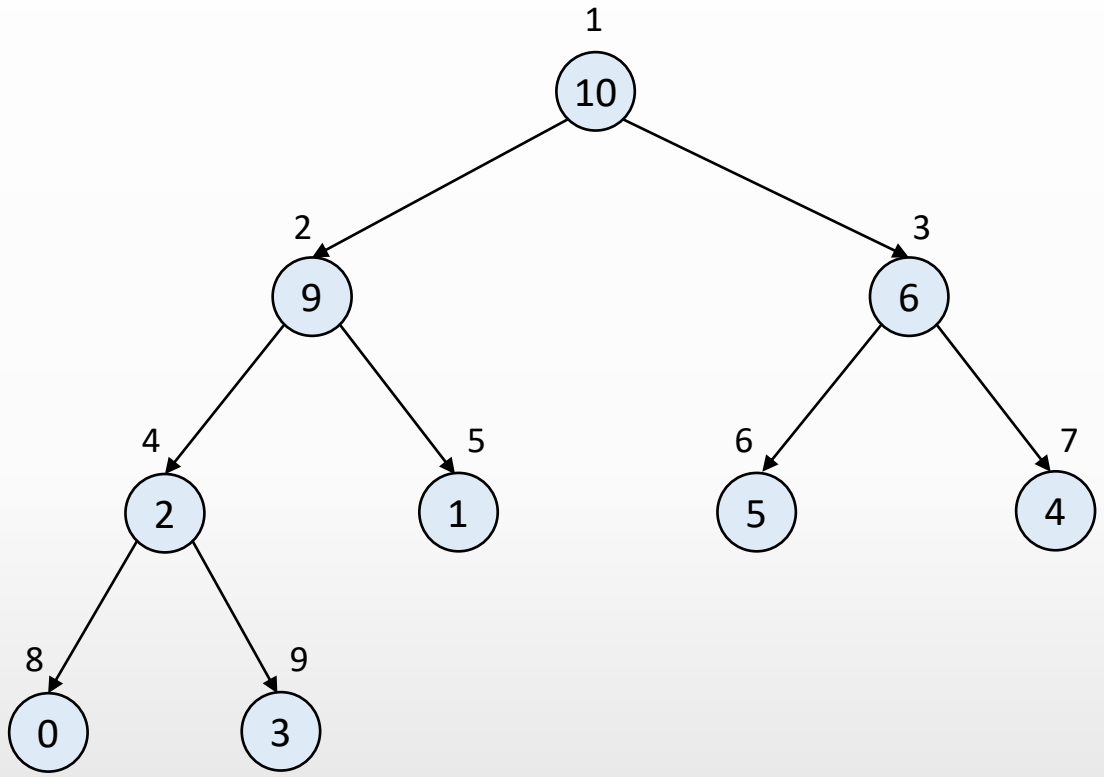
```
silMax()
```



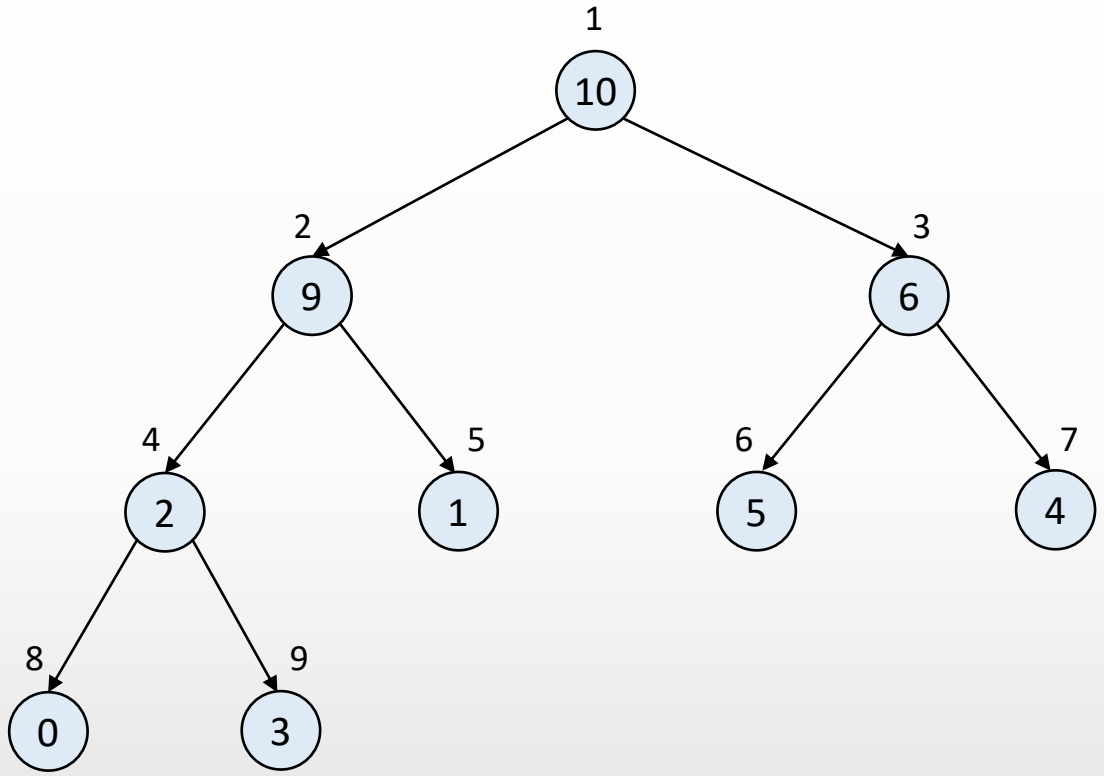

```
max = 9
```

Yukarıdan Aşağıya Heap Ağacına Dönüştürme

Sercan KÜLCÜ, Tüm hakları saklıdır.

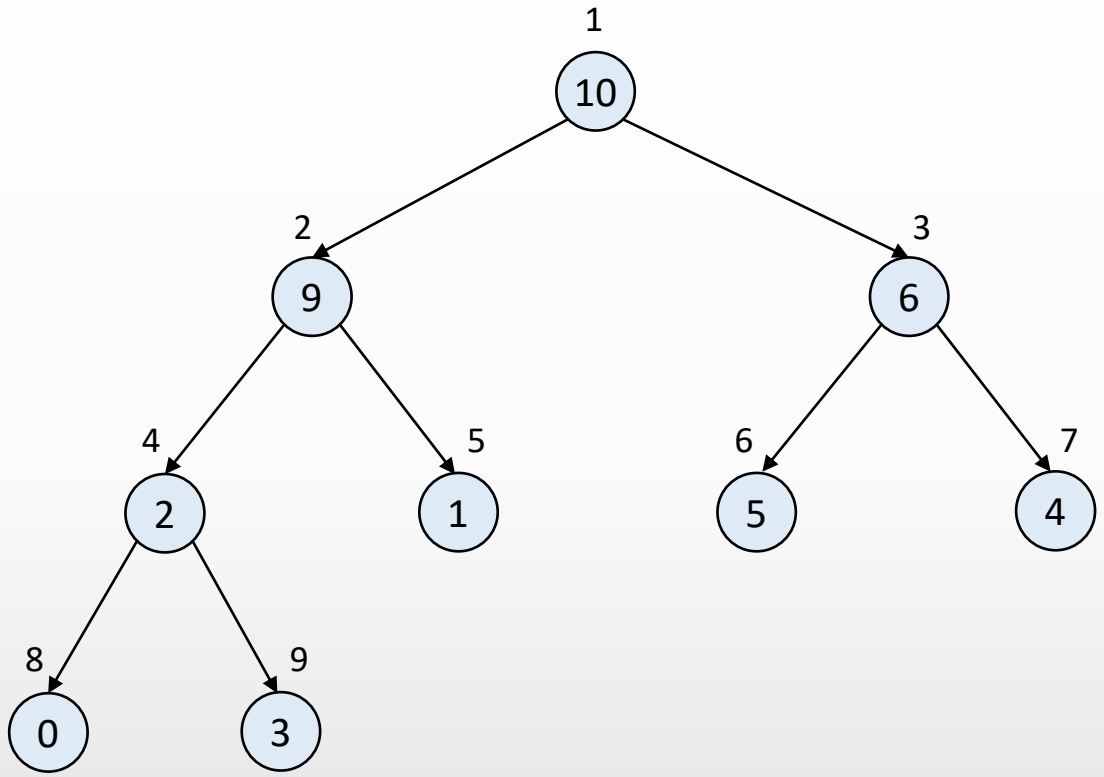

1
10
2
9
3
6
4
2
5
1
6
5
7
4
8
0
9
3

silMax()



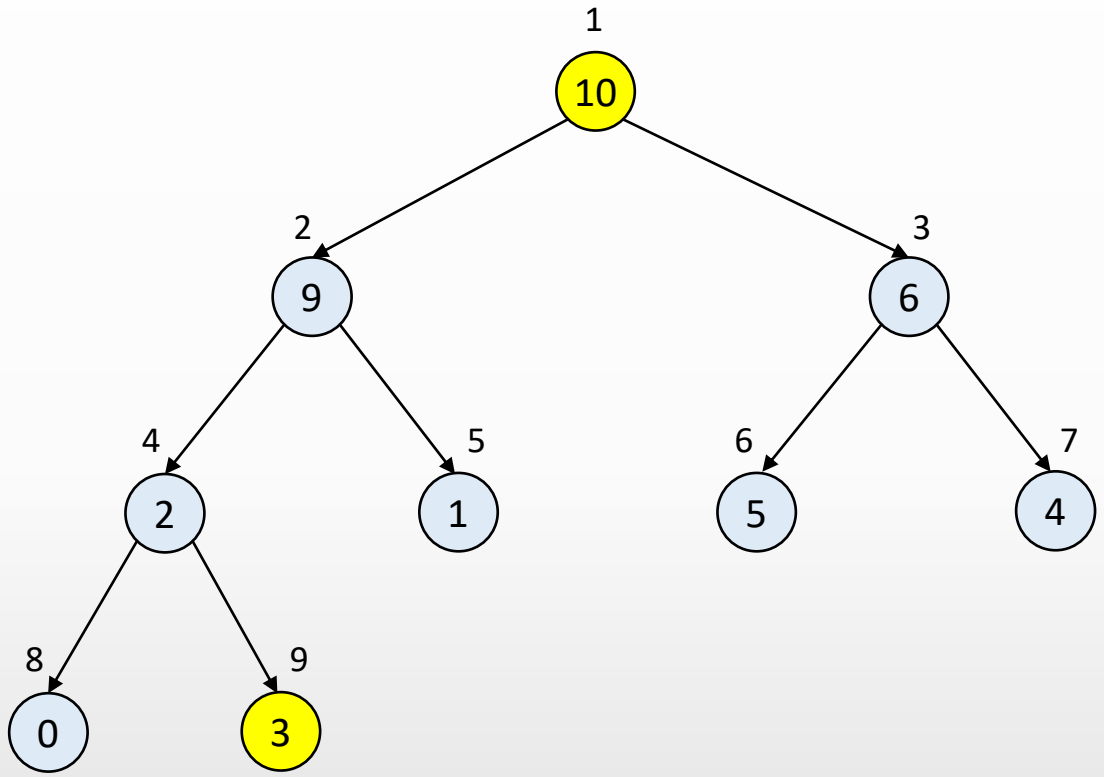
silMax()

max = 10



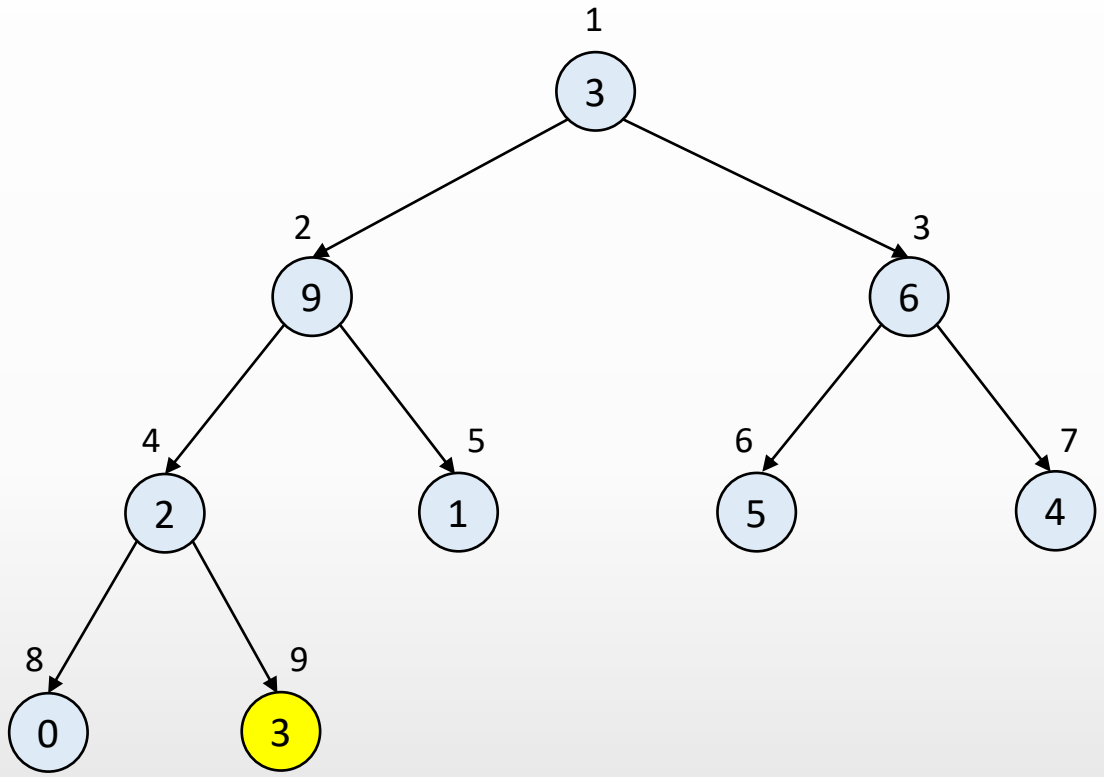
silMax()

max = 10



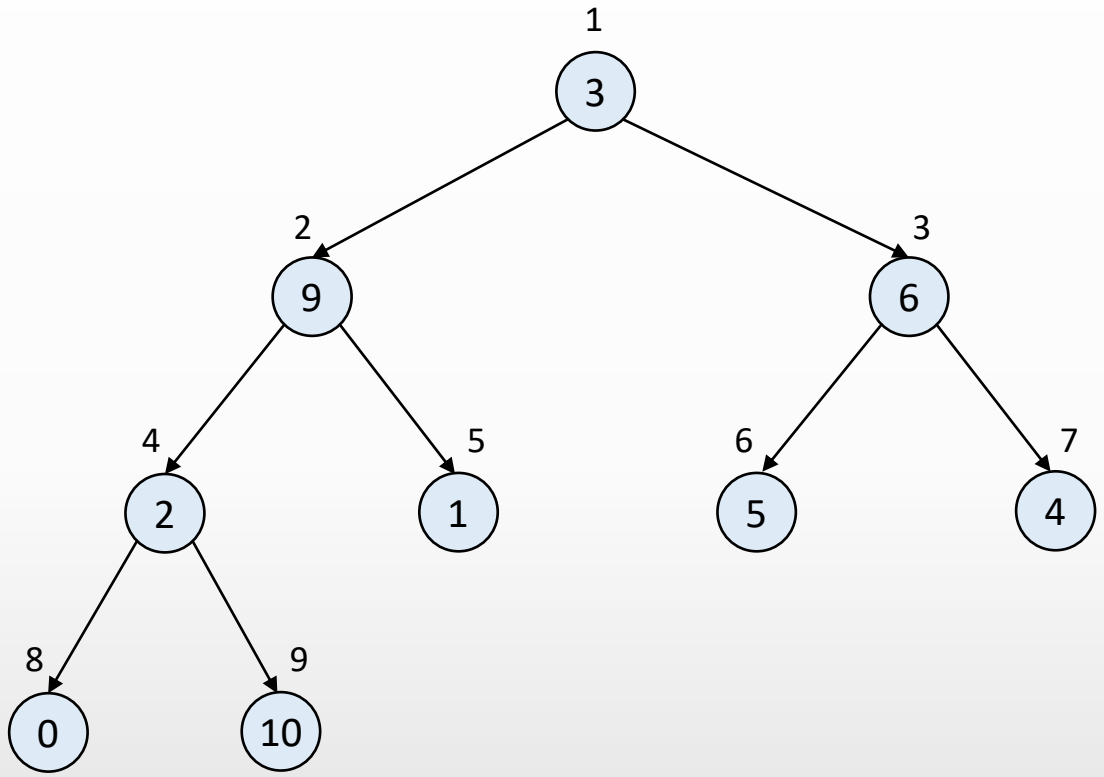
silMax()

max = 10



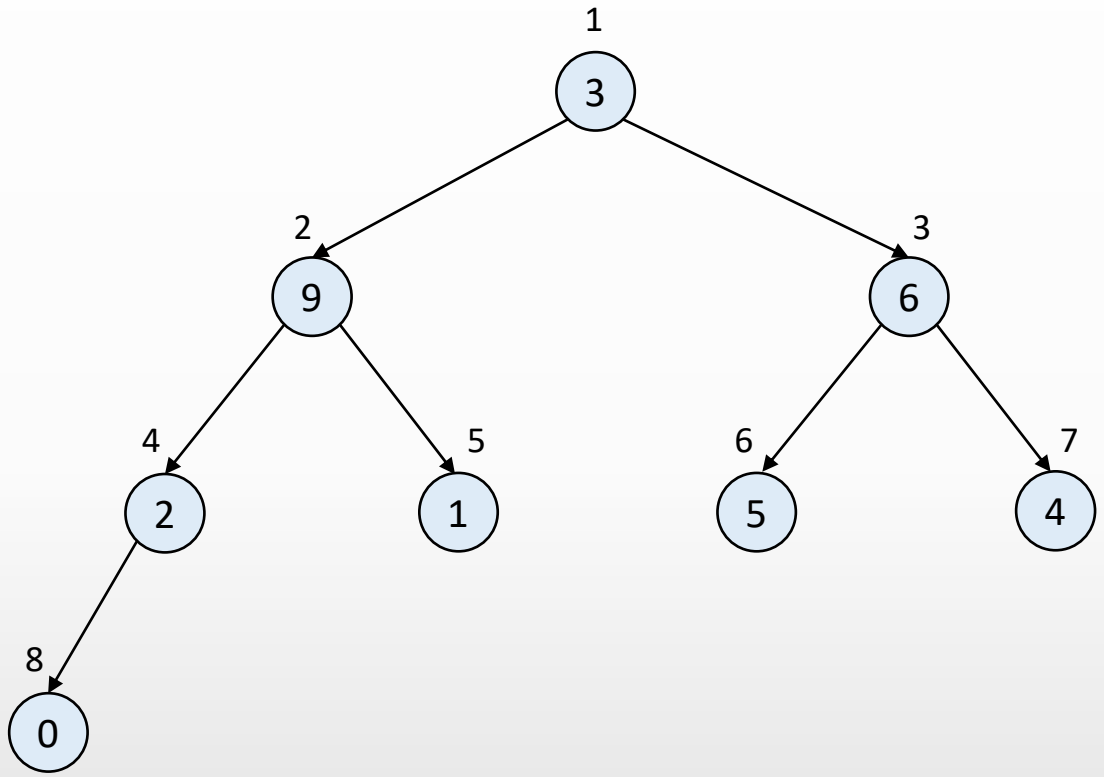
silMax()

max = 10



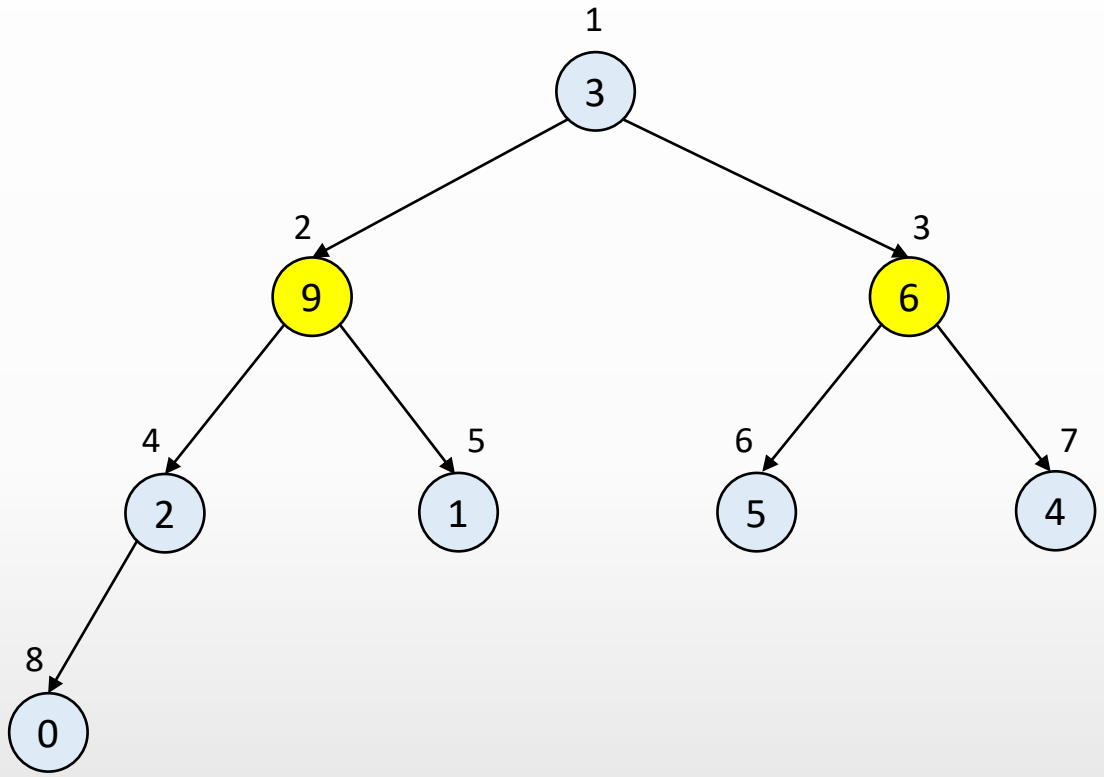
silMax()

max = 10



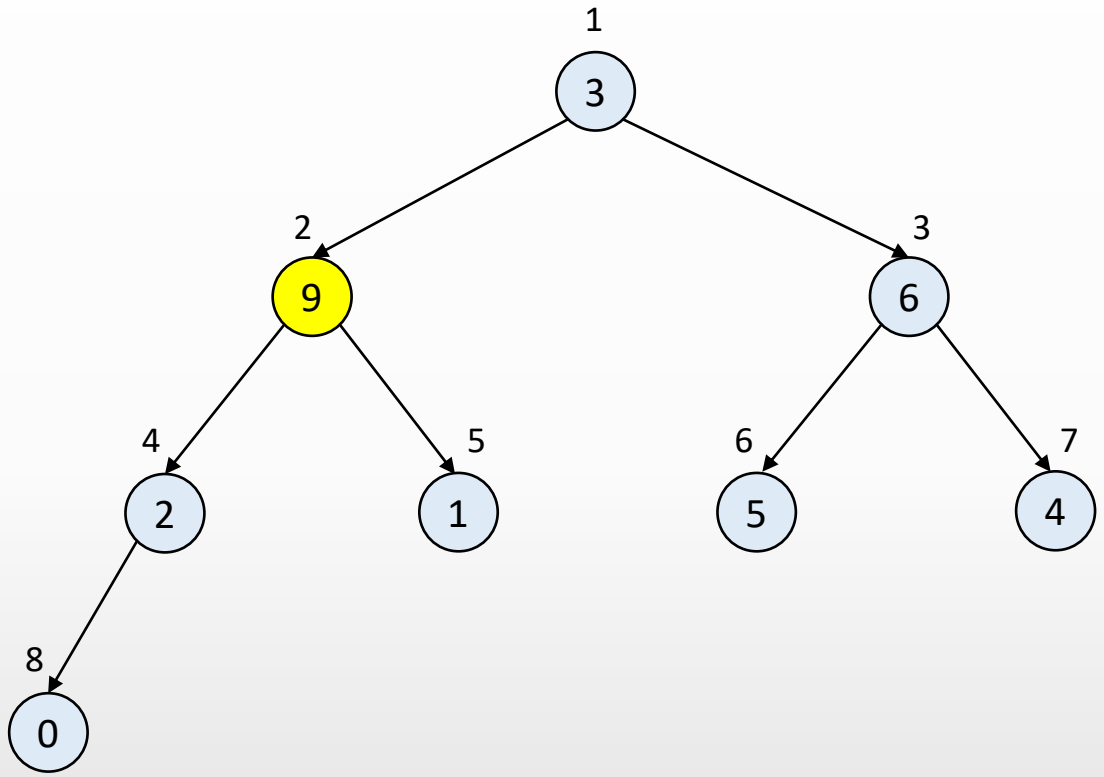
```
silMax()
```

```
max = 10
```



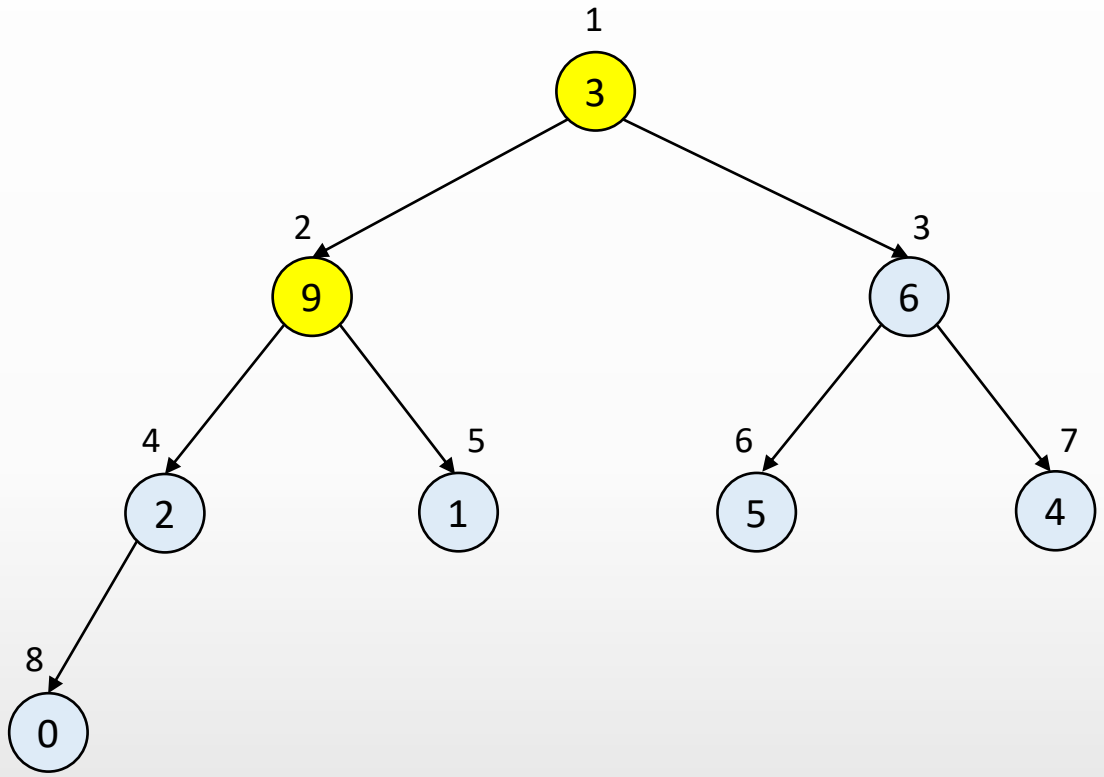
silMax()

max = 10



silMax()

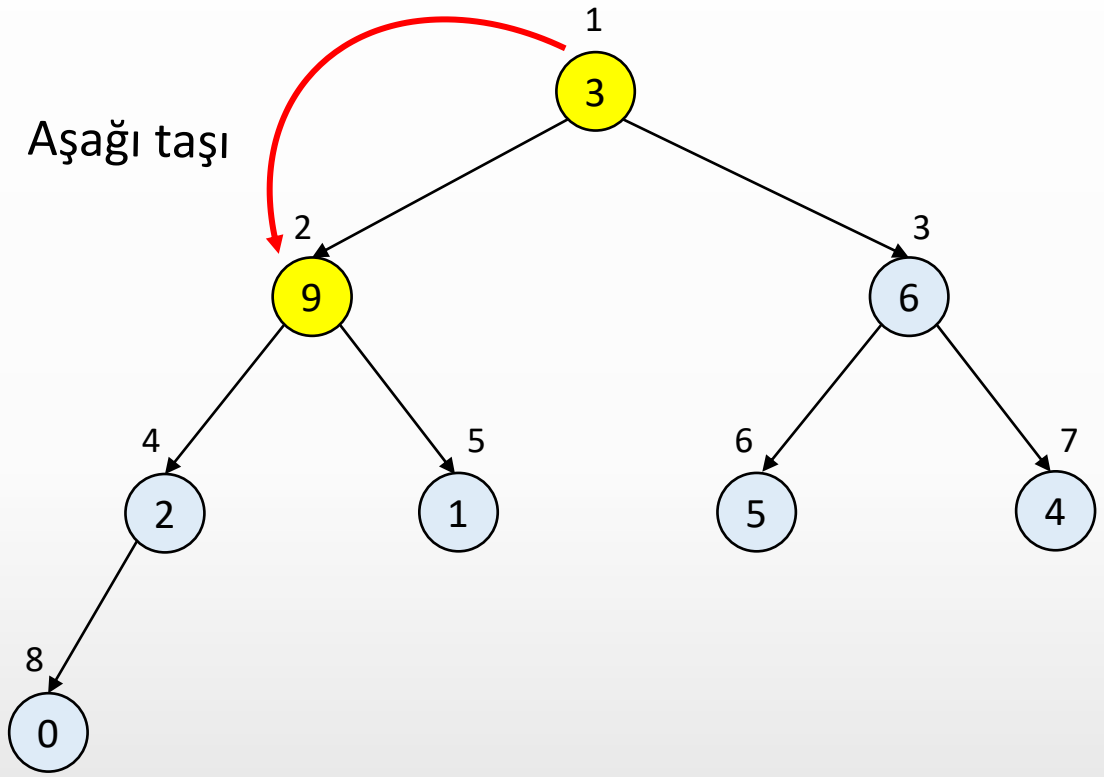
max = 10



`silMax()`

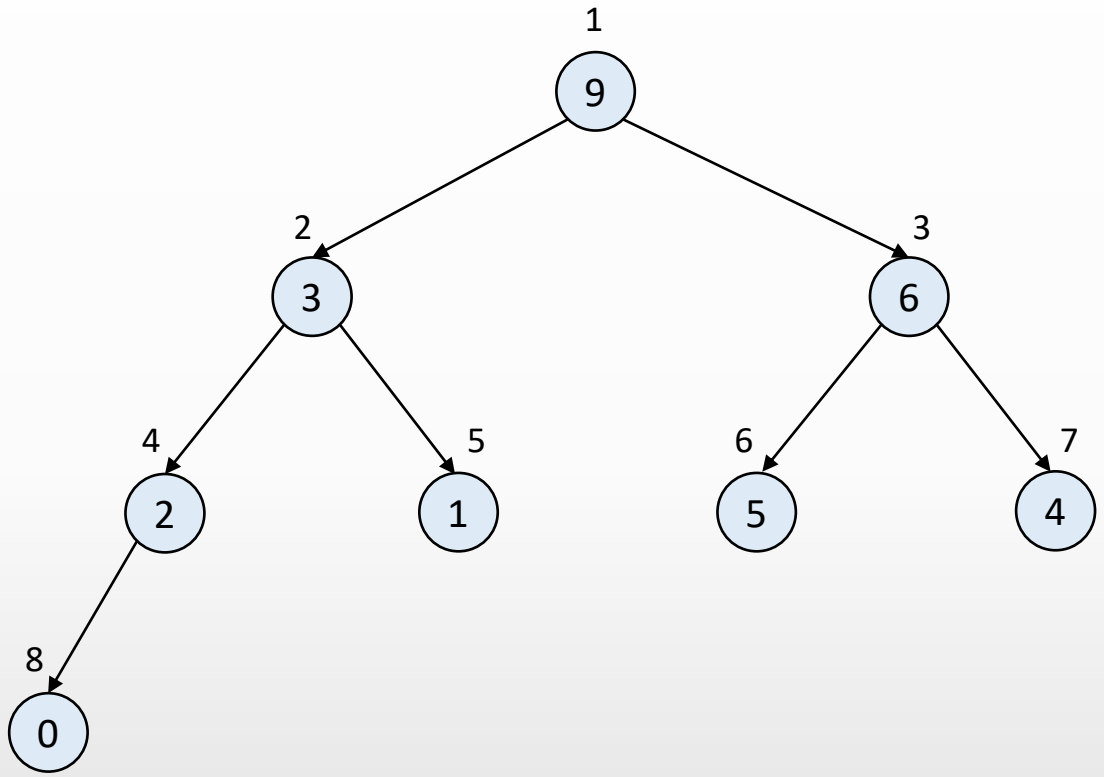
`max = 10`

Aşağı taşı



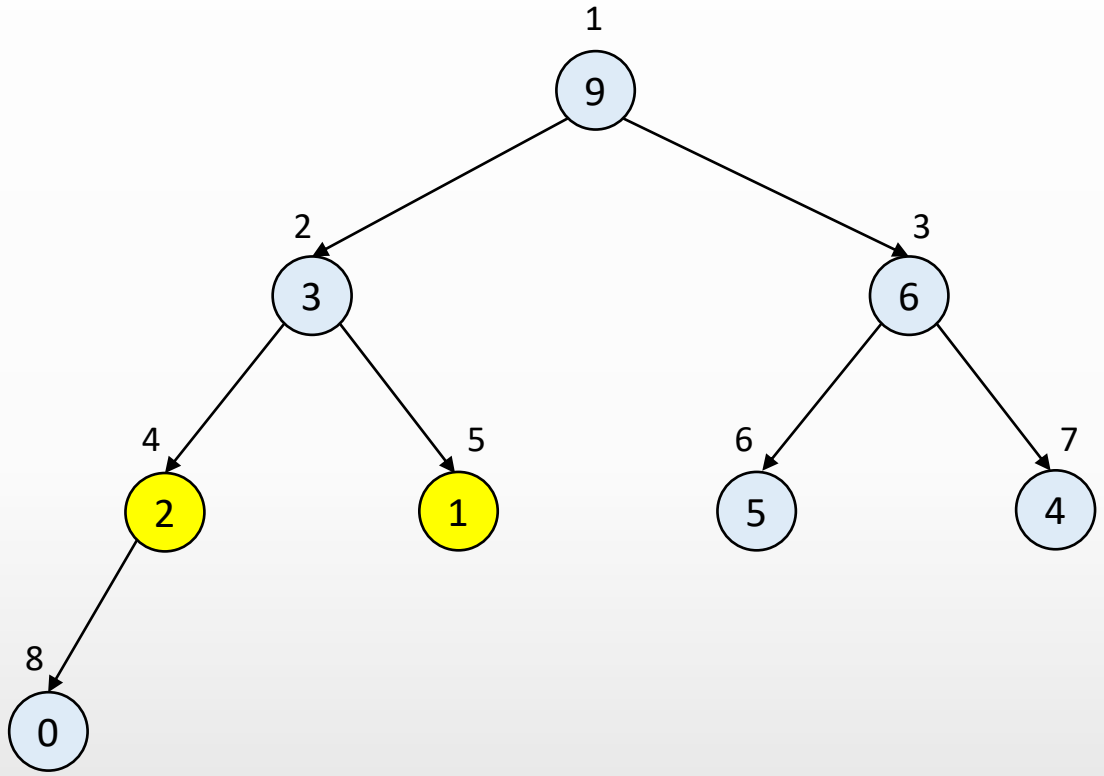
silMax()

max = 10



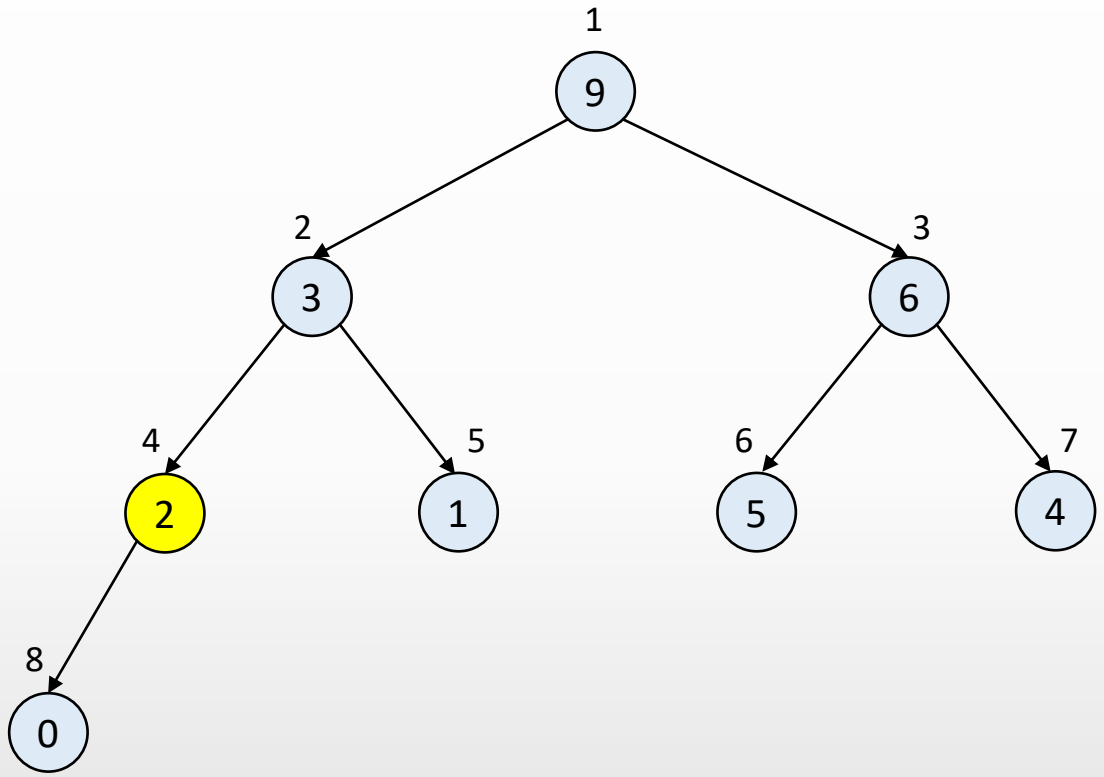
```
silMax()
```

max = 10



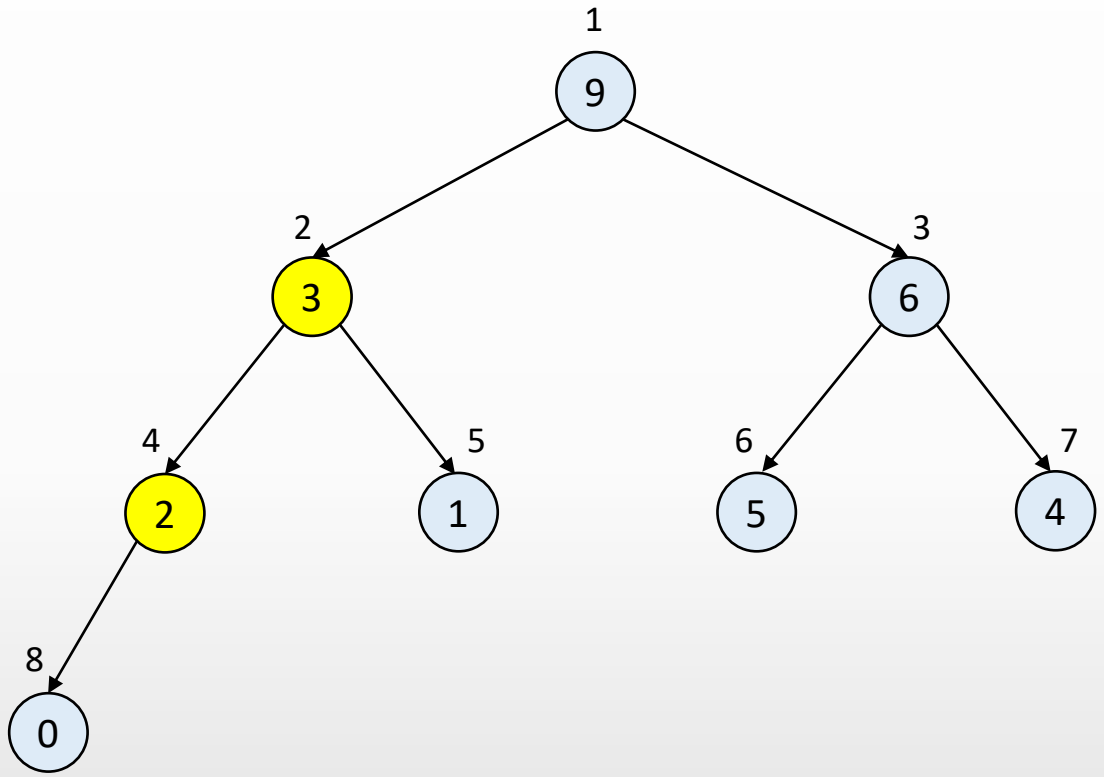
```
silMax()
```

```
max = 10
```



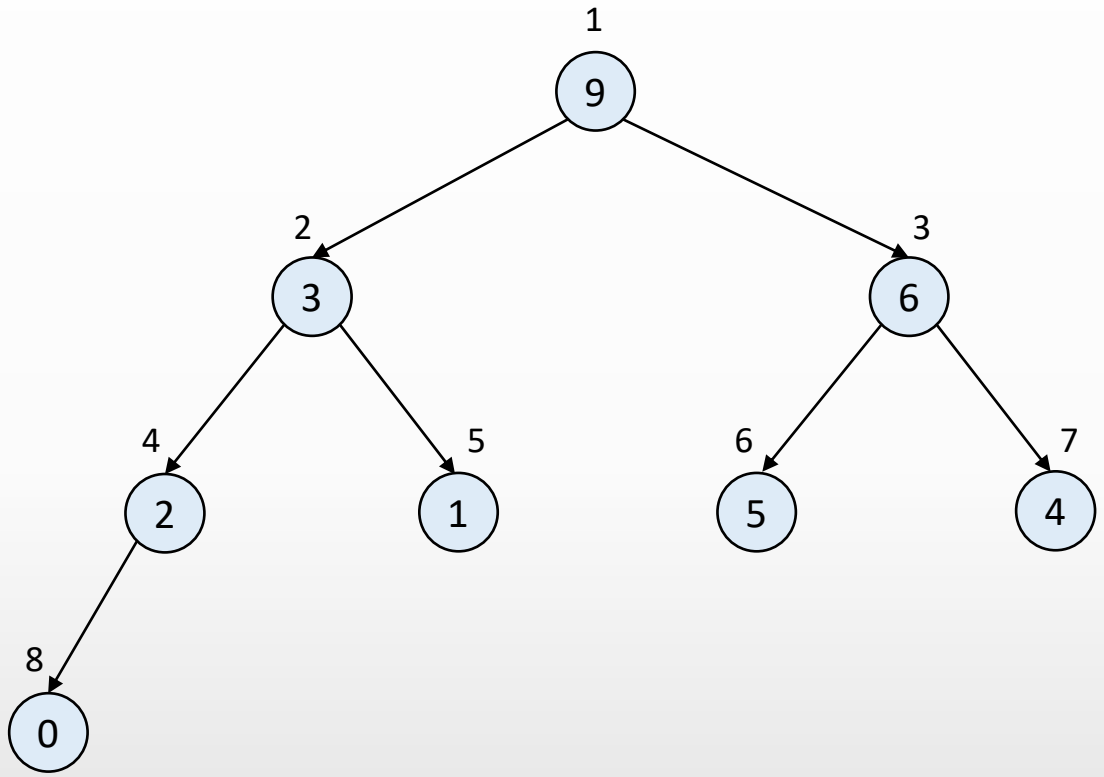
```
silMax()
```

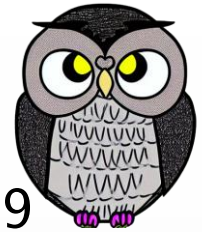
```
max = 10
```



silMax()

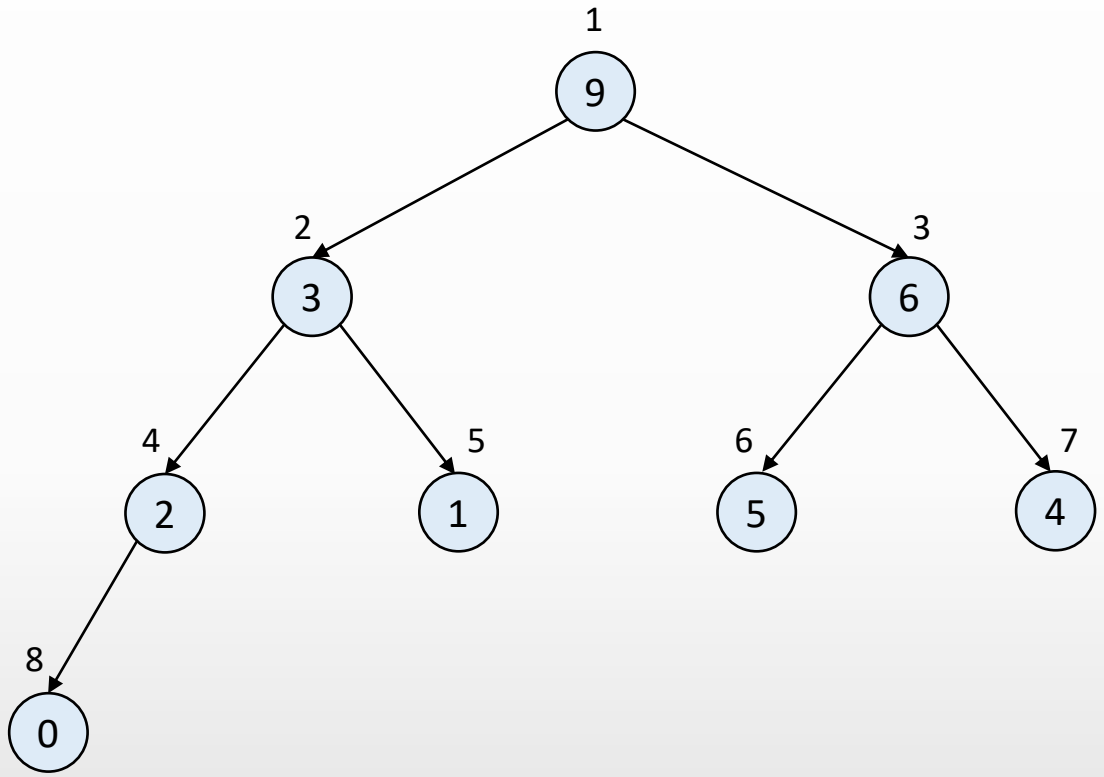
max = 10



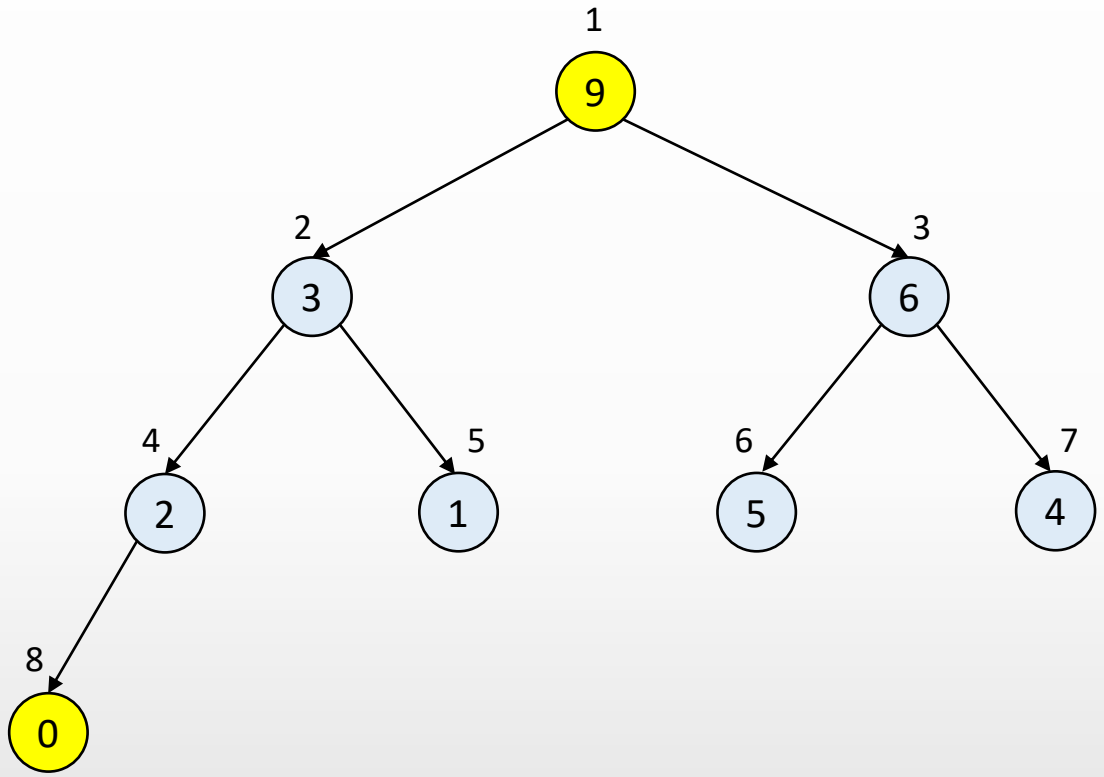


silMax()

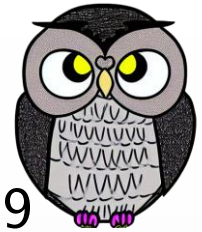
max = 9



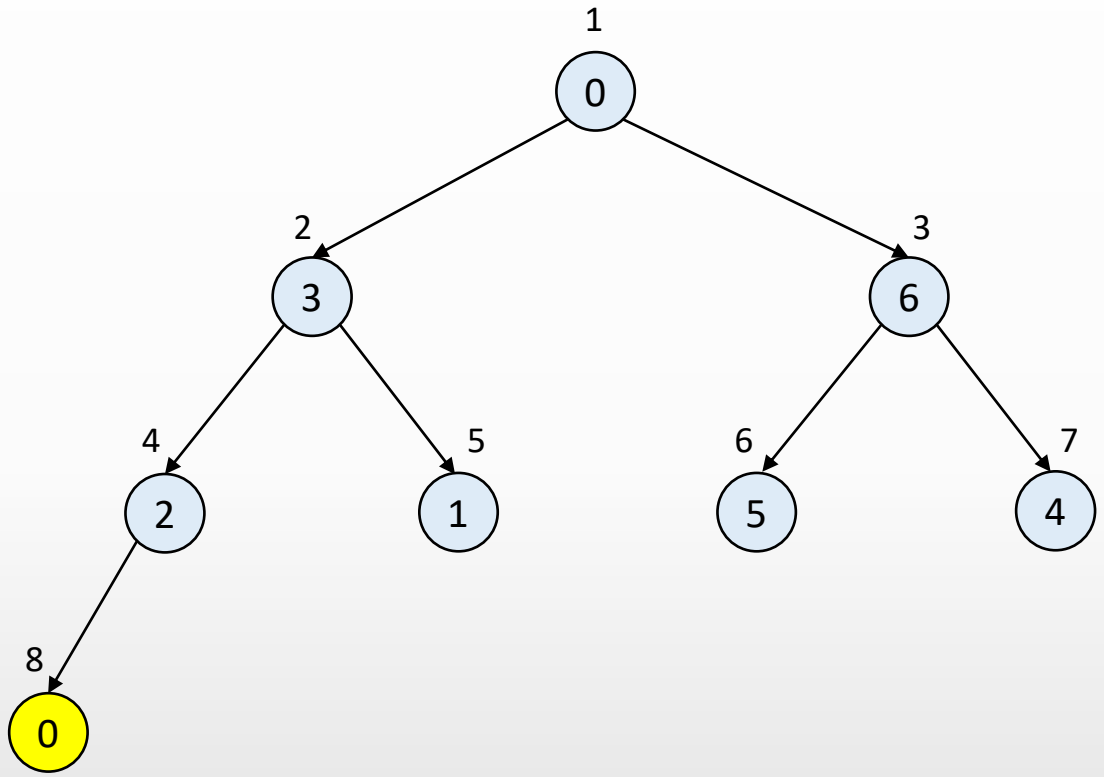
silMax()



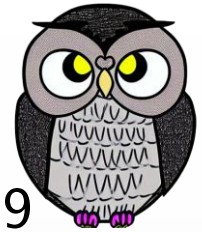
max = 9

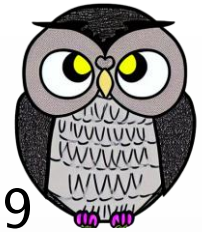


silMax()



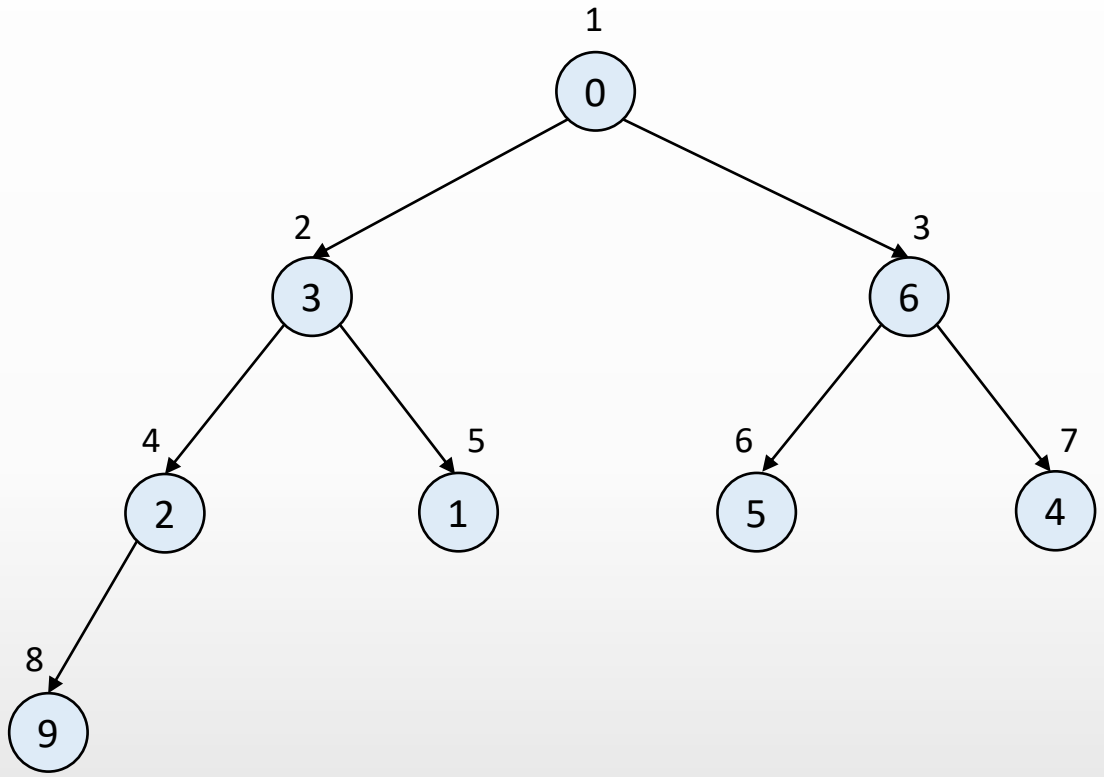
max = 9



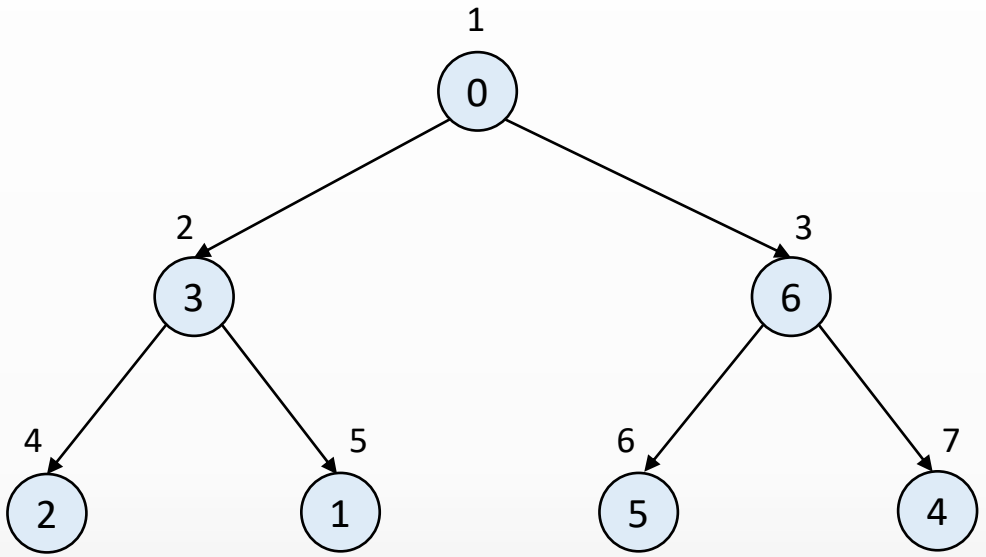


silMax()

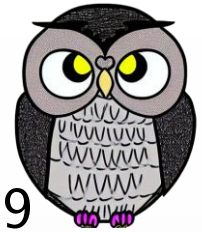
max = 9

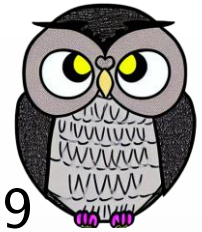


silMax()



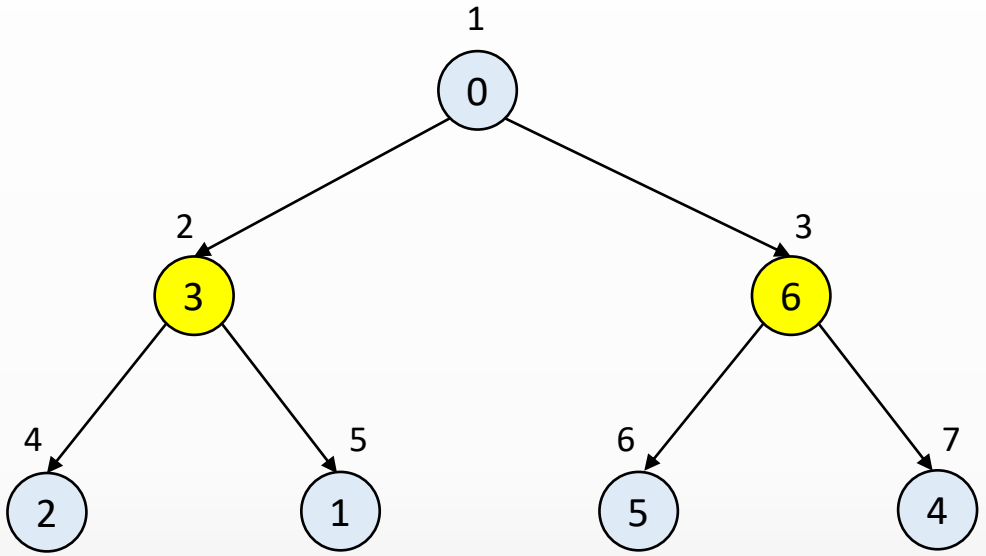
max = 9

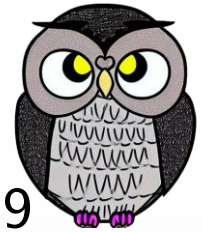




silMax()

max = 9





```
silMax()
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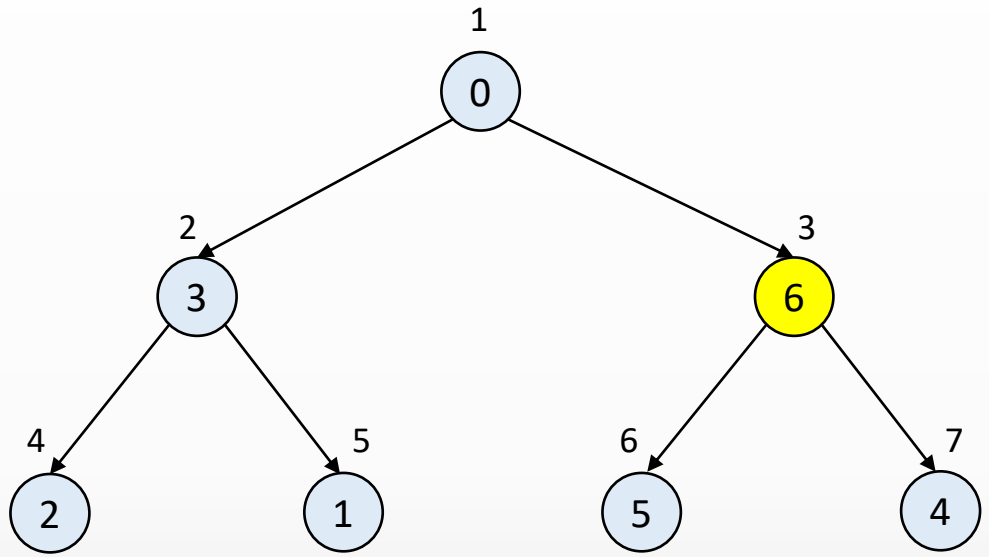


```
max = 9
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```
silMax()
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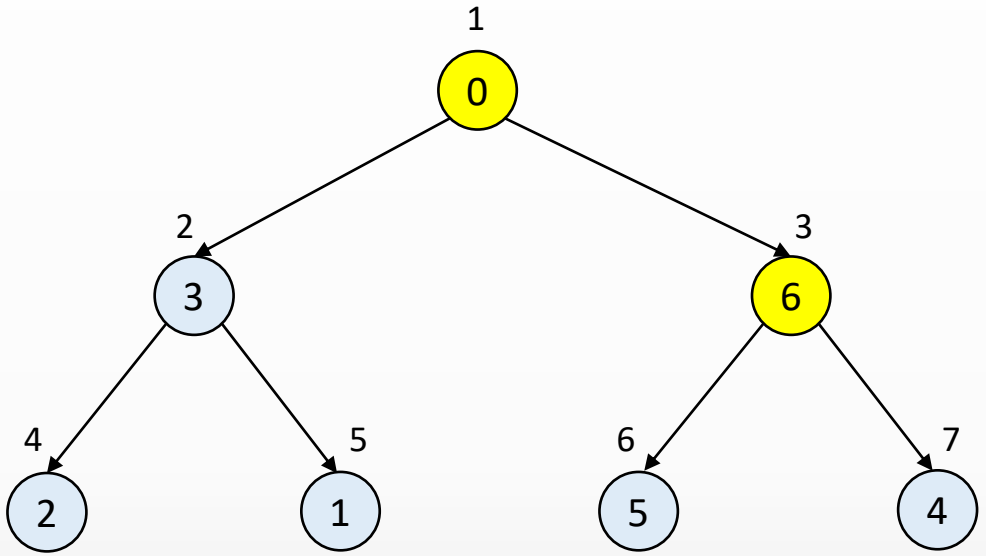


```
max = 9
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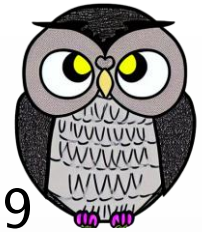
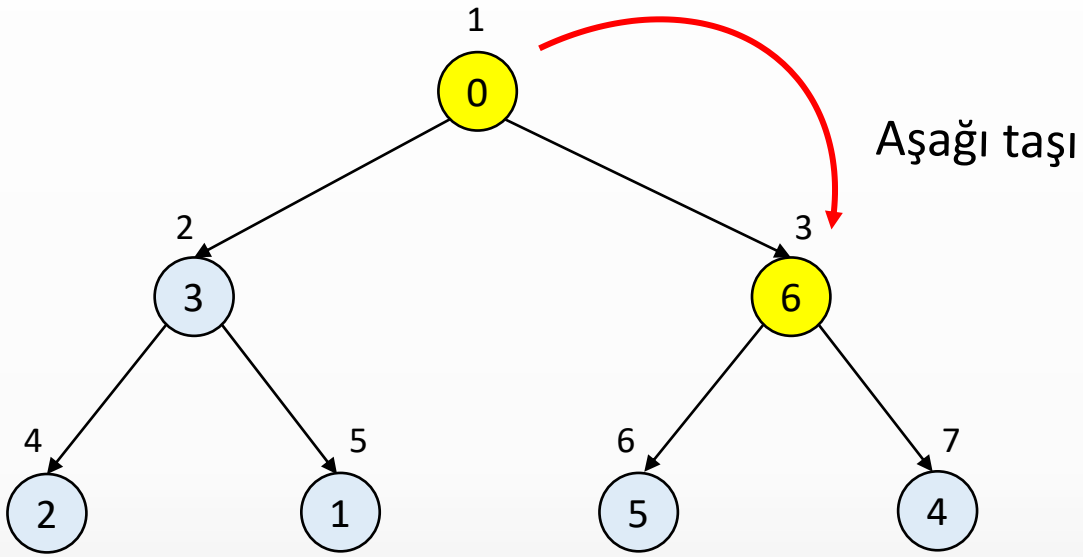
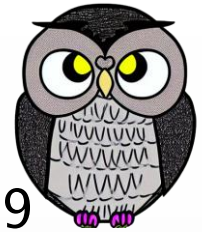
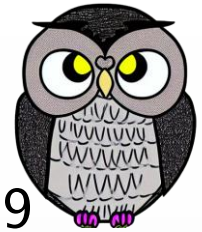


silMax()



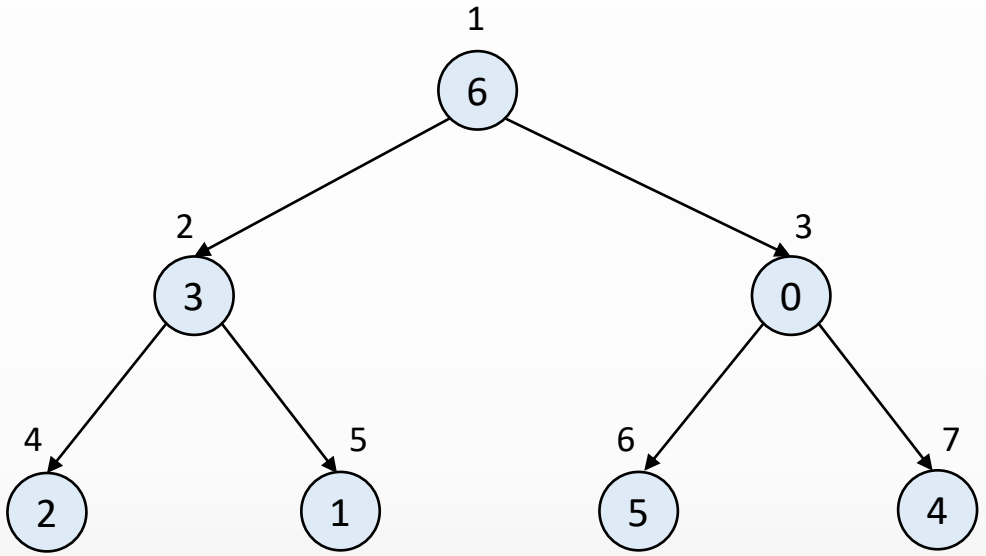
max = 9



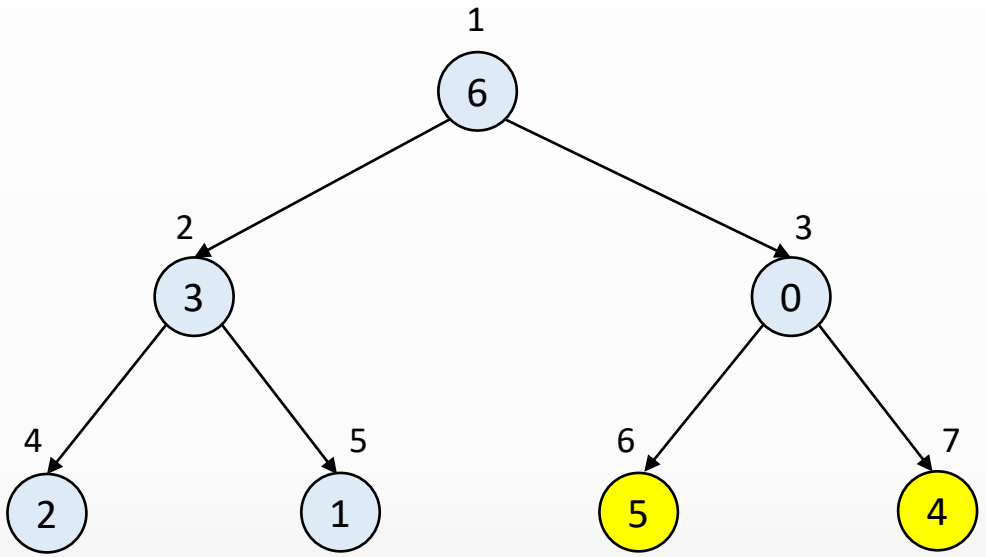


silMax()

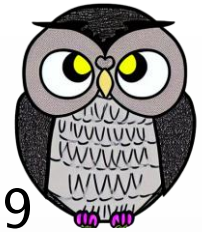
max = 9



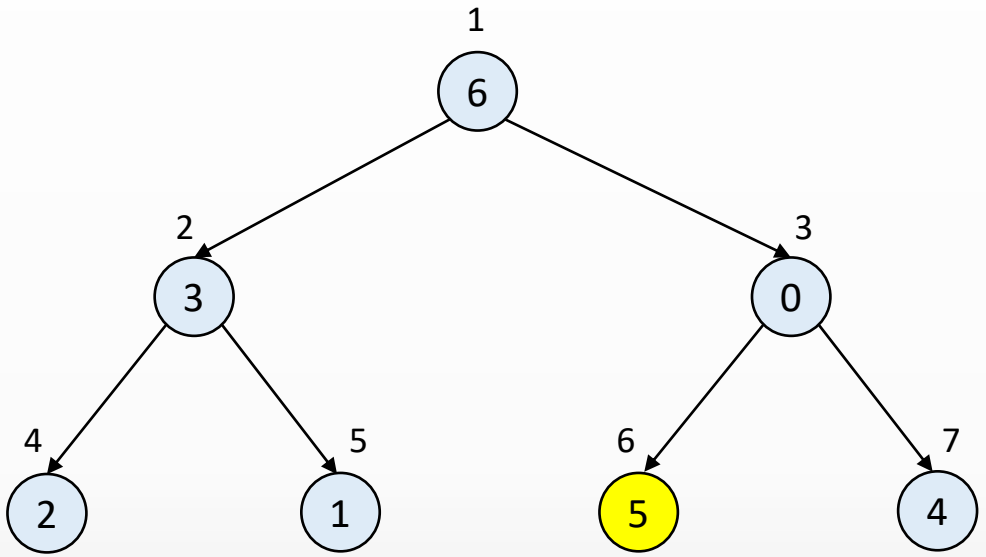
silMax()



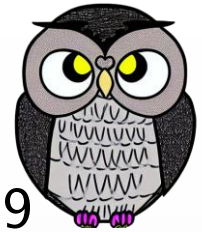
max = 9

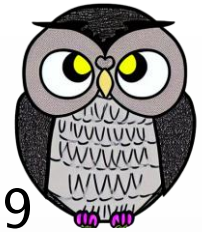


silMax()



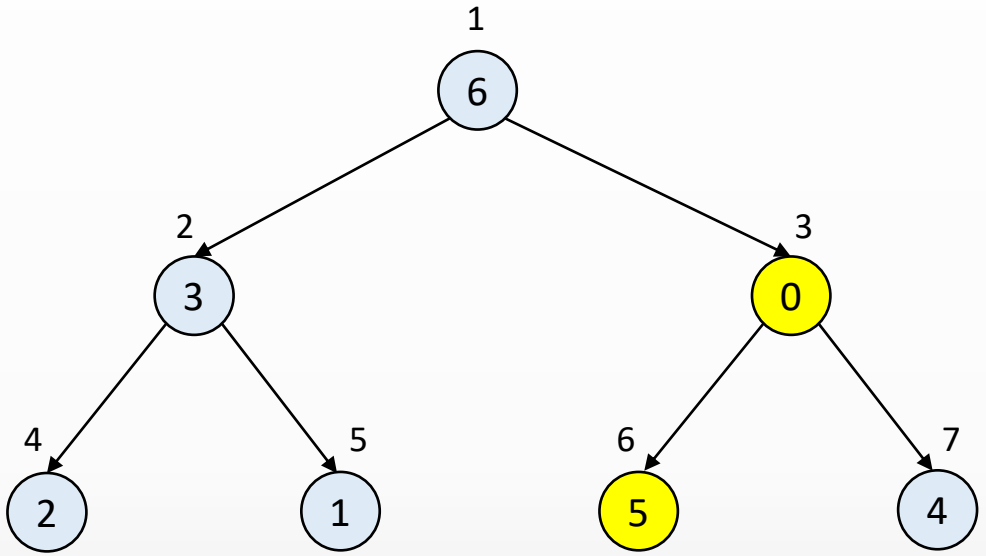
max = 9





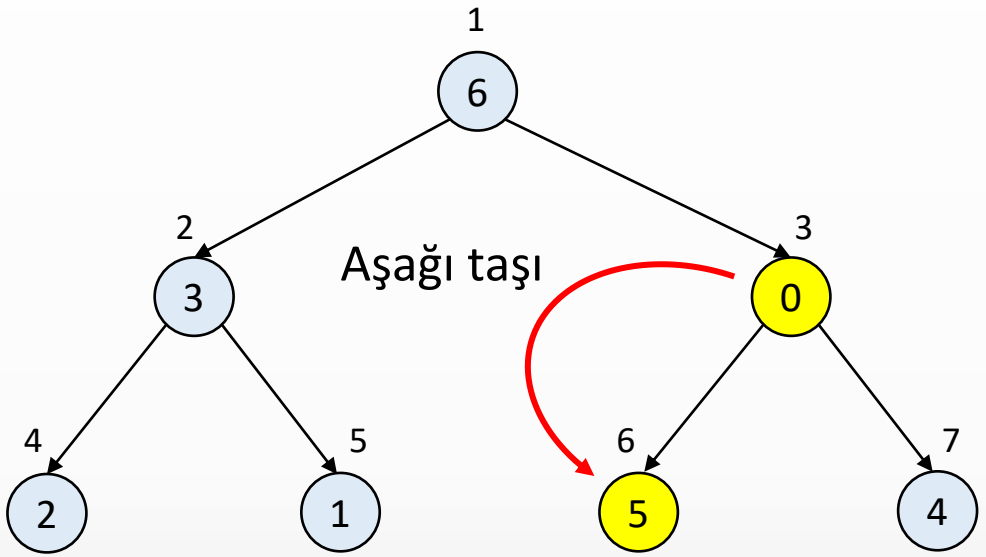
silMax()

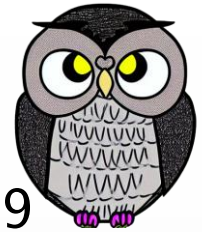
max = 9



silMax()

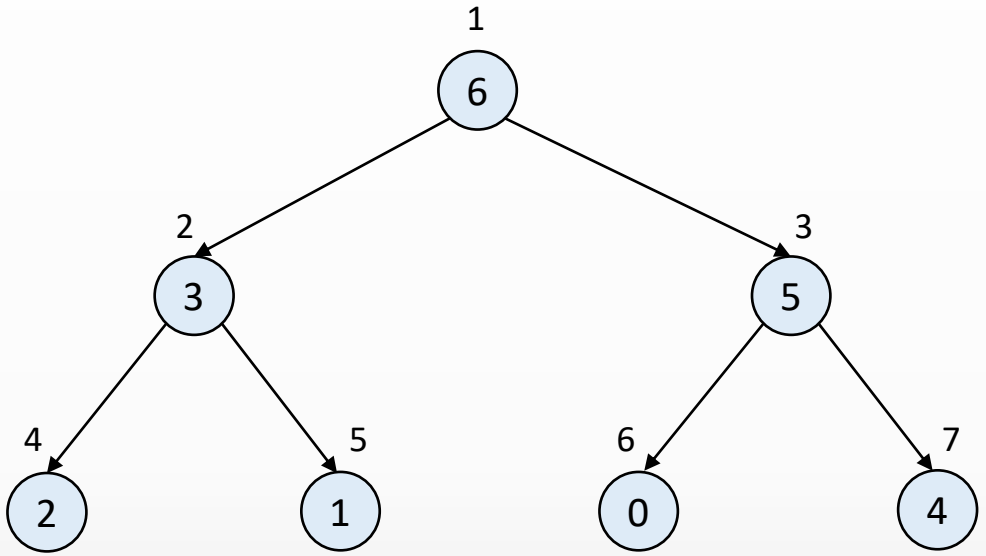
max = 9





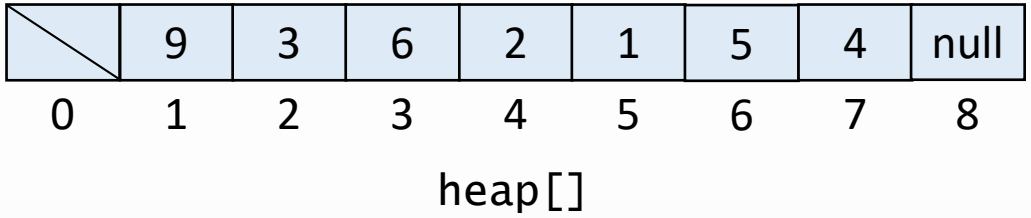
silMax()

max = 9



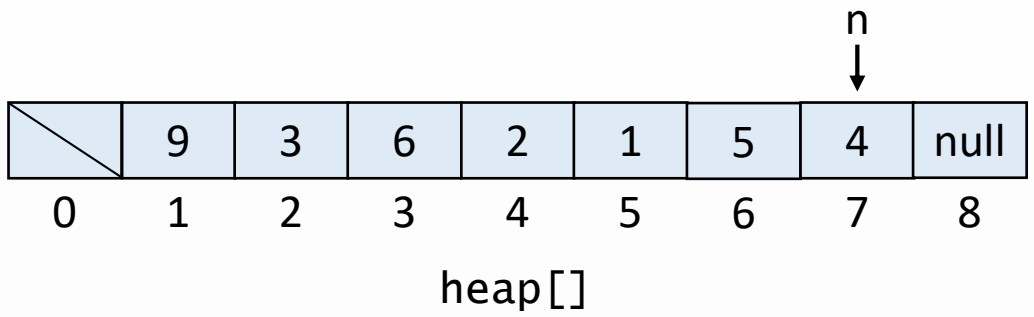
Max Heap Ağacında En Büyük Elemanı Silme

Sercan KÜLCÜ, Tüm hakları saklıdır.



```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

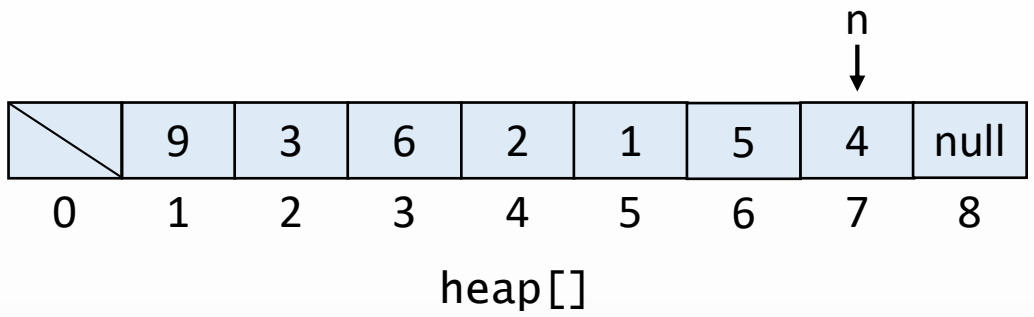
public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```



n = 7

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

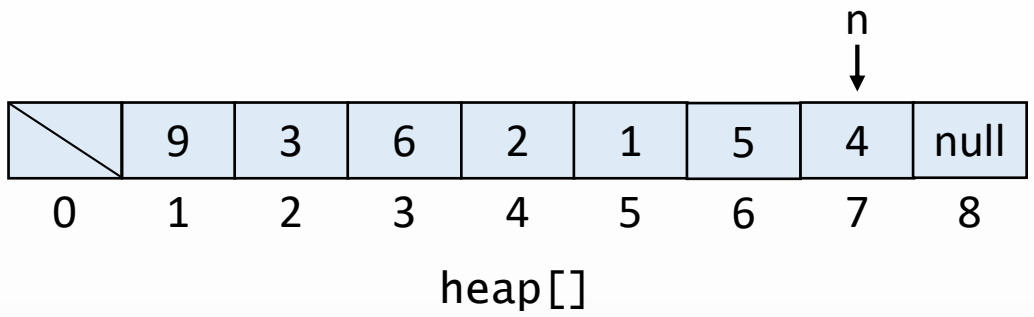


n = 7

silMax()

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```



n = 7

silMax()

```
public int silMax() {
  int max = heap[1];
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  n--;
  batir(1);
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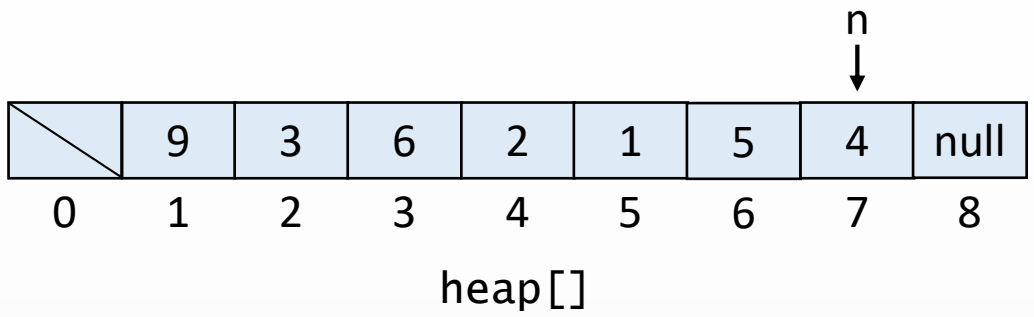
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

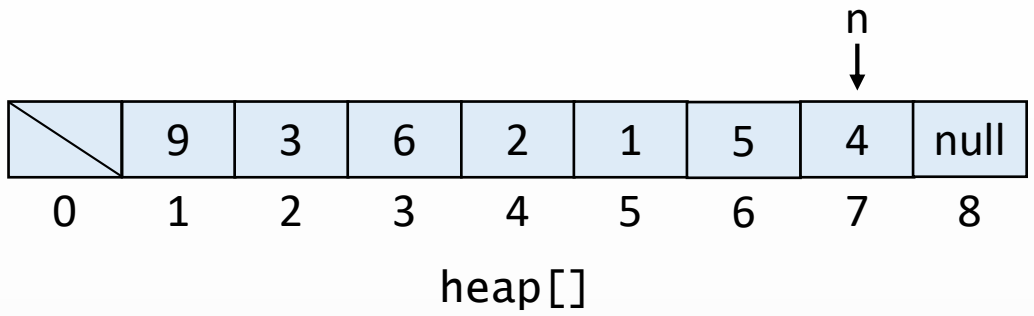


```
max = 9
n = 7


silMax()
```

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```



```
max = 9
n = 7


silMax()
```

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
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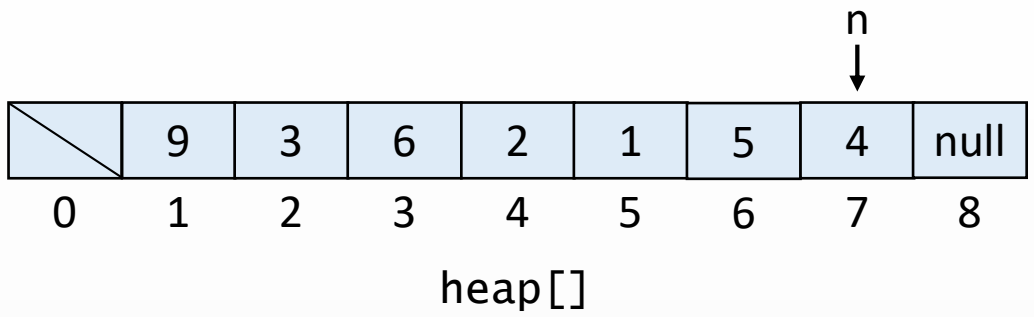
public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```



max = 9
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silMax()

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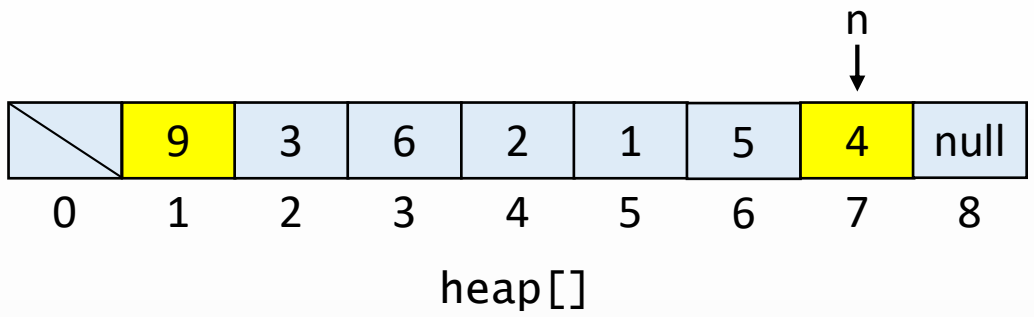
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

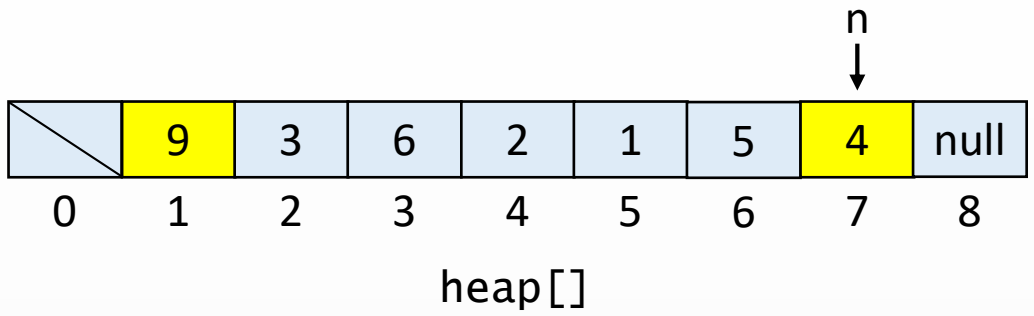


```
b = 7
a = 1
max = 9
n = 7


silMax()
```

```java
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

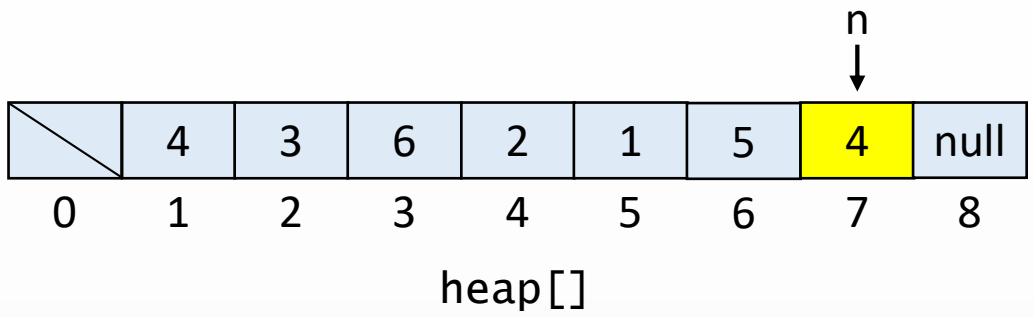


```
gecici = 9
b = 7
a = 1
max = 9
n = 7


silMax()
```

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

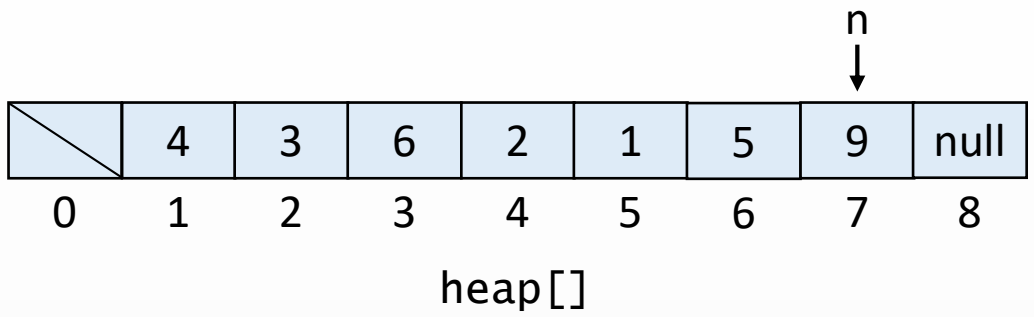


```
gecici = 9
b = 7
a = 1
max = 9
n = 7


silMax()
```

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

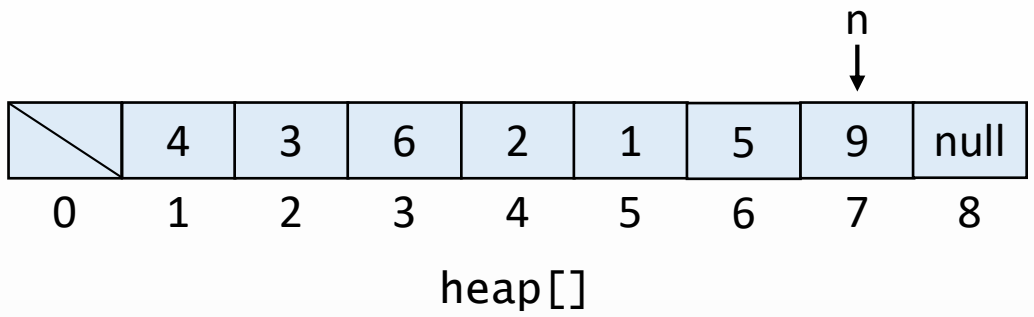


```
gecici = 9
b = 7
a = 1
max = 9
n = 7


silMax()
```

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

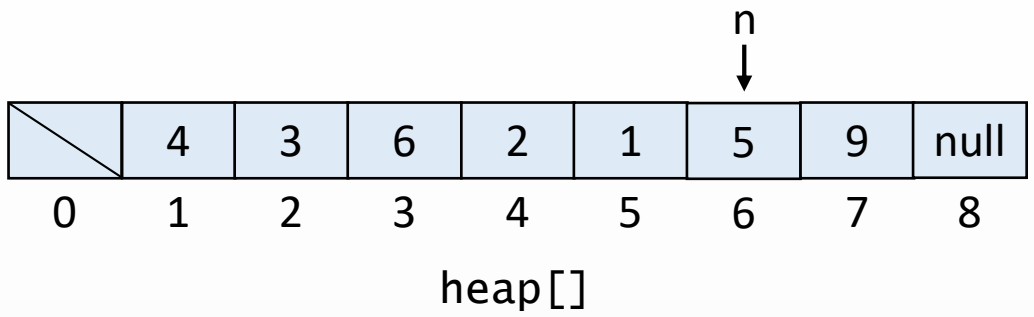


```
max = 9
n = 7


silMax()
```

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

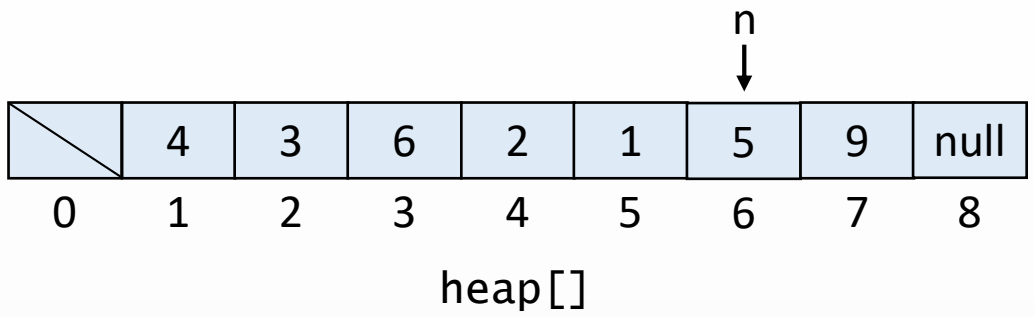


```
max = 9
n = 6


silMax()
```

```java
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

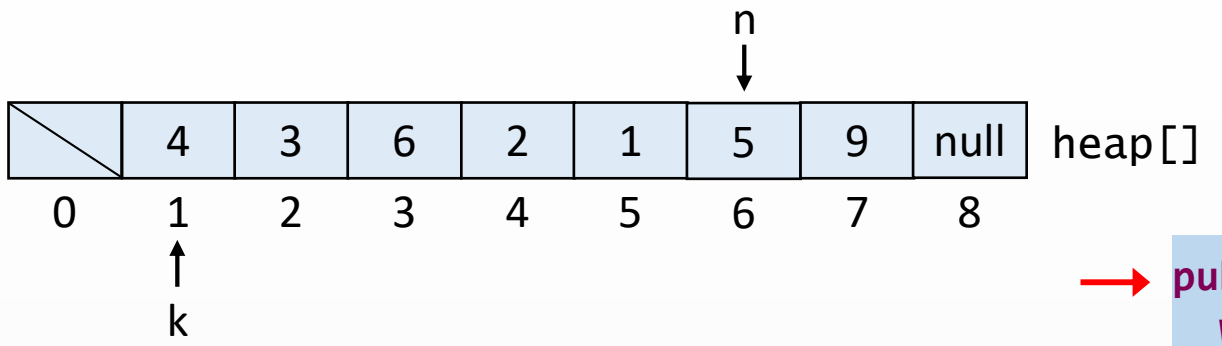


```
max = 9
n = 6


silMax()
```

```java
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

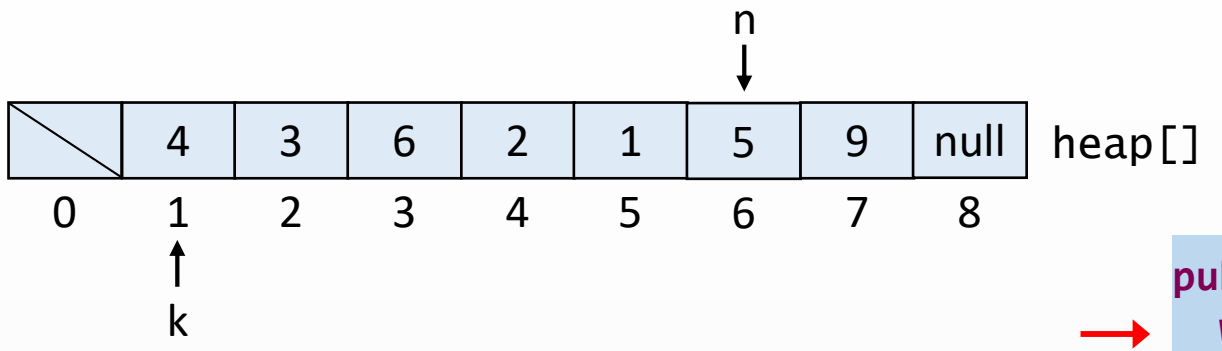



```
k = 1
max = 9
n = 6


silMax()
```

```java
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

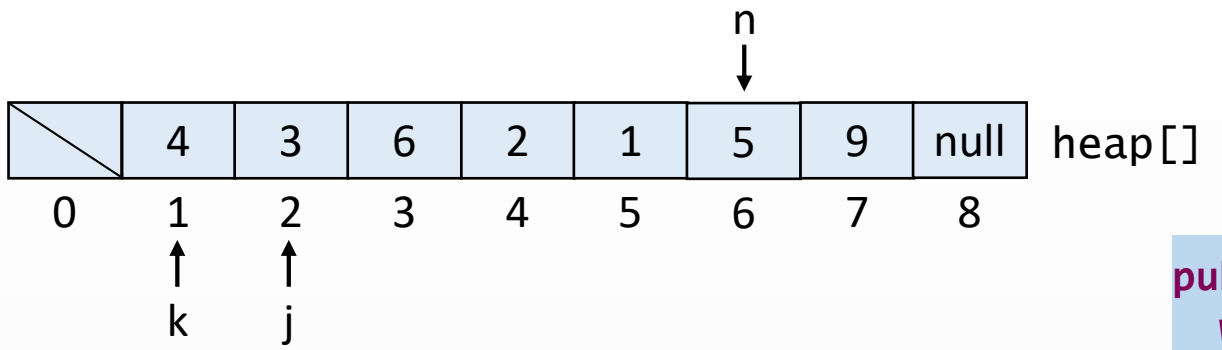



```
k = 1
max = 9
n = 6


silMax()
```

```java
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

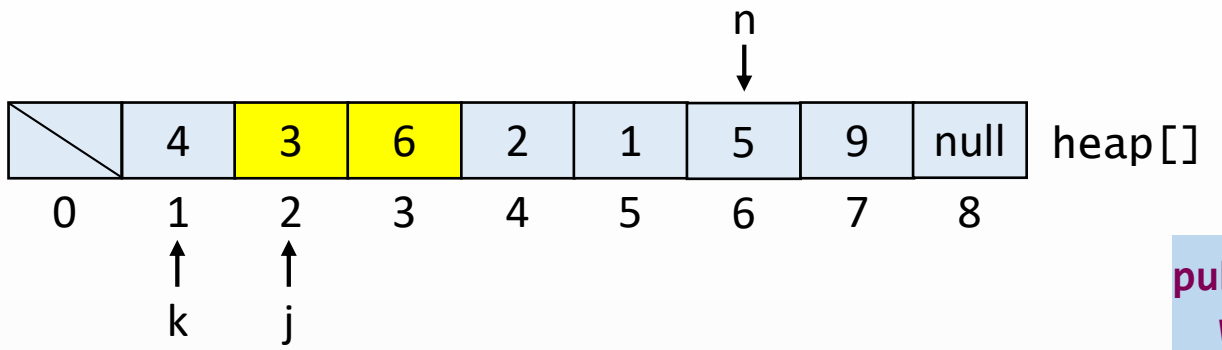


```
j = 2
k = 1
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

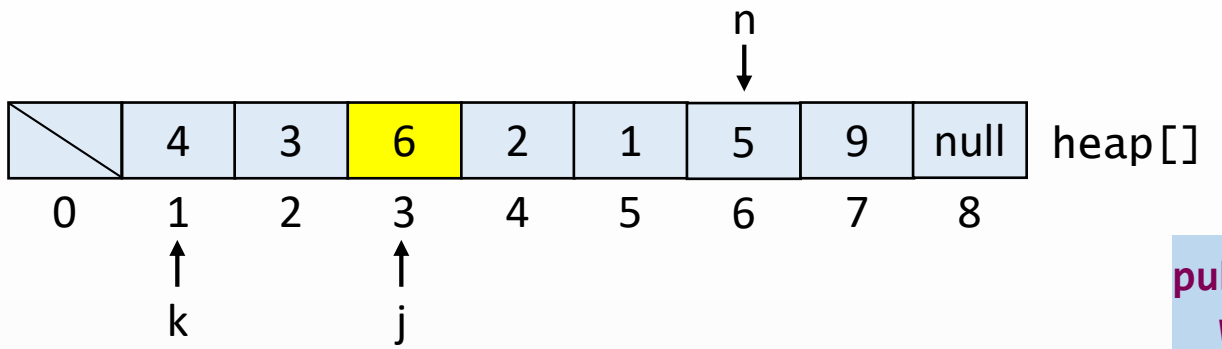


```
j = 2
k = 1
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

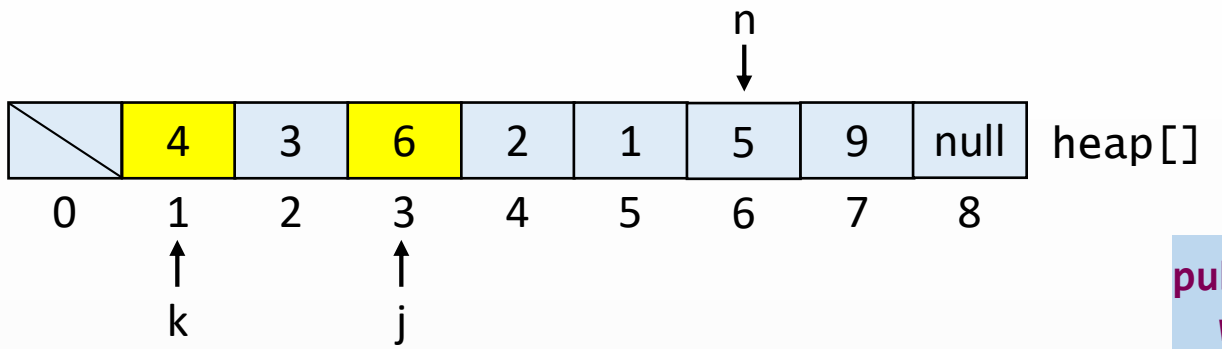


```
j = 3
k = 1
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

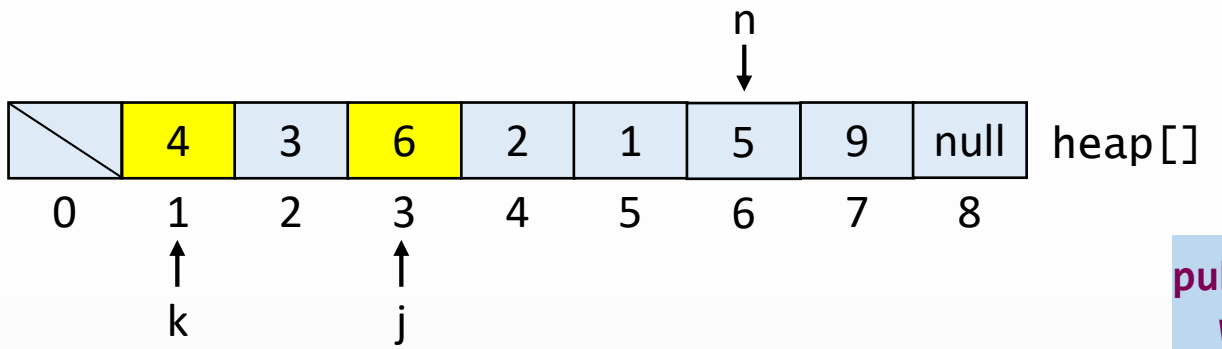


```
j = 3
k = 1
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

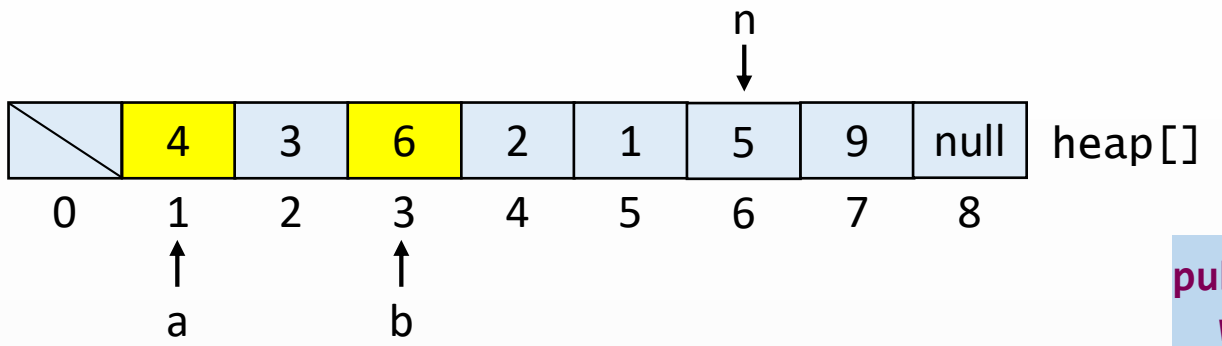



```
j = 3
k = 1
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

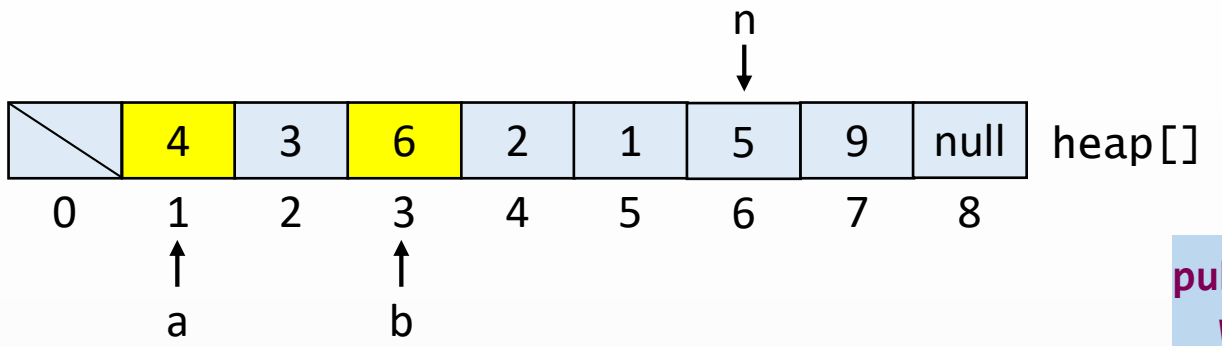


```
b = 3
a = 1
j = 3
k = 1
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

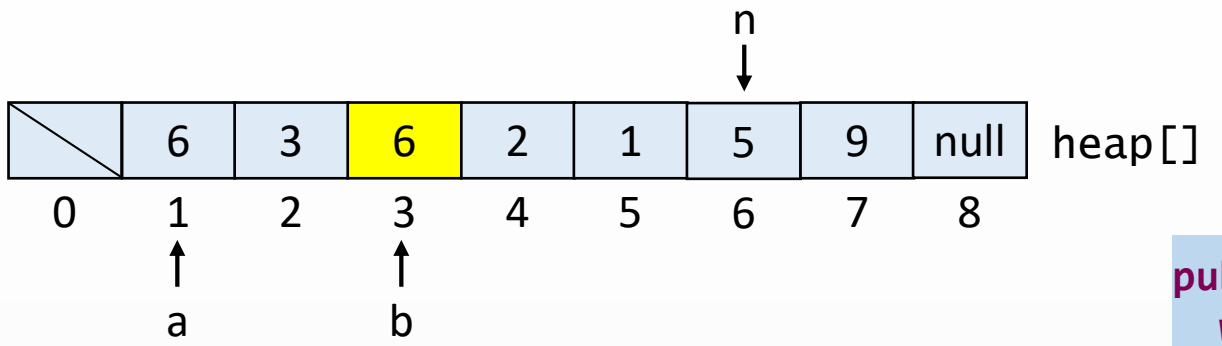


```
gecici = 4
b = 3
a = 1
j = 3
k = 1
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

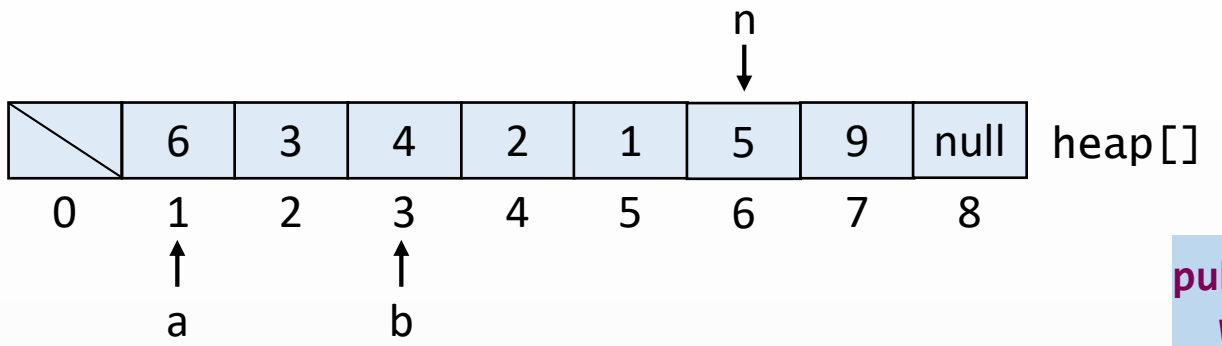


```
gecici = 4
b = 3
a = 1
j = 3
k = 1
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

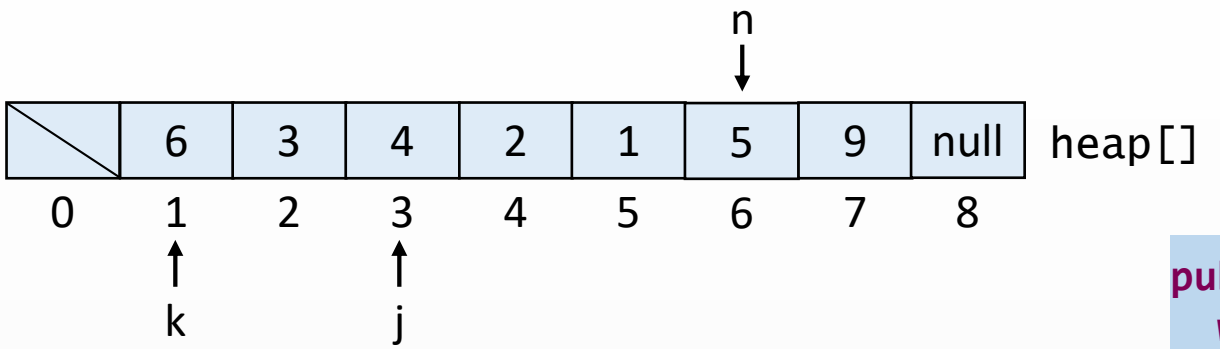


```
gecici = 4
b = 3
a = 1
j = 3
k = 1
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

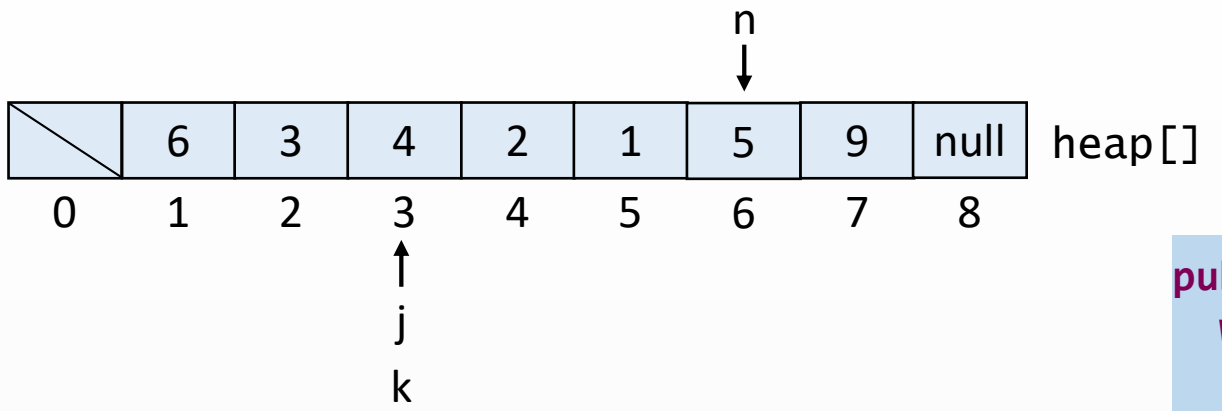


```
j = 3
k = 1
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

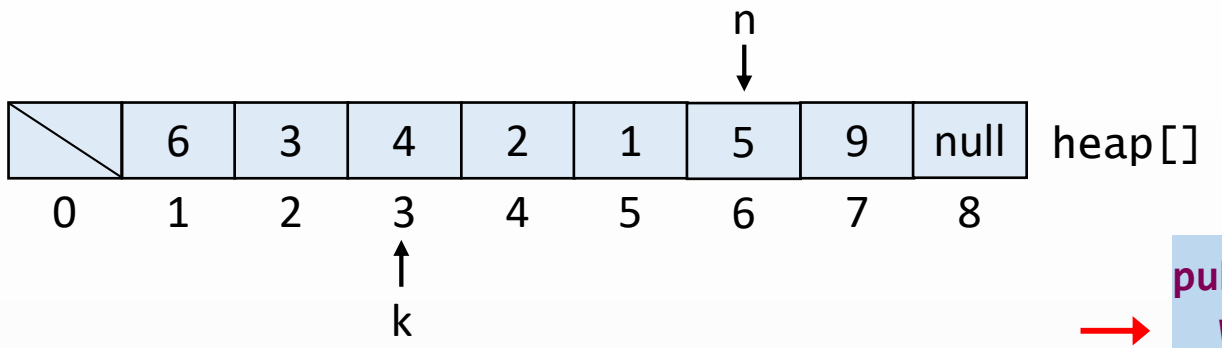



```
j = 3
k = 3
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

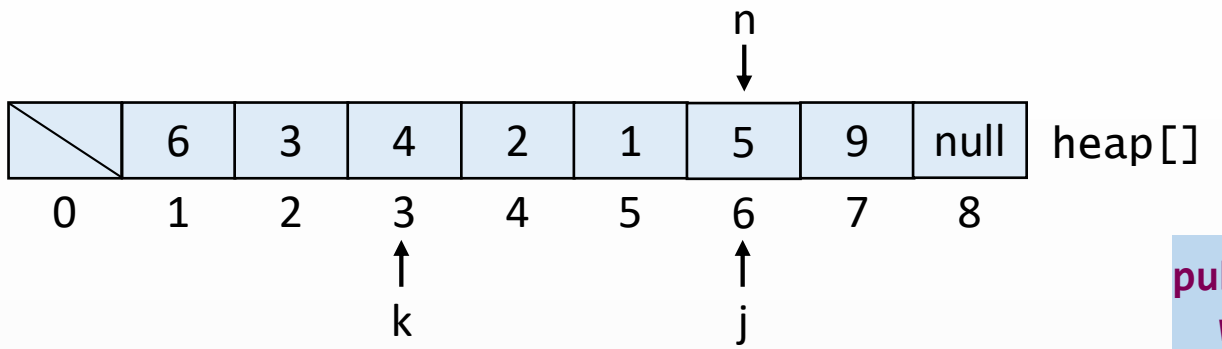


```
k = 3
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

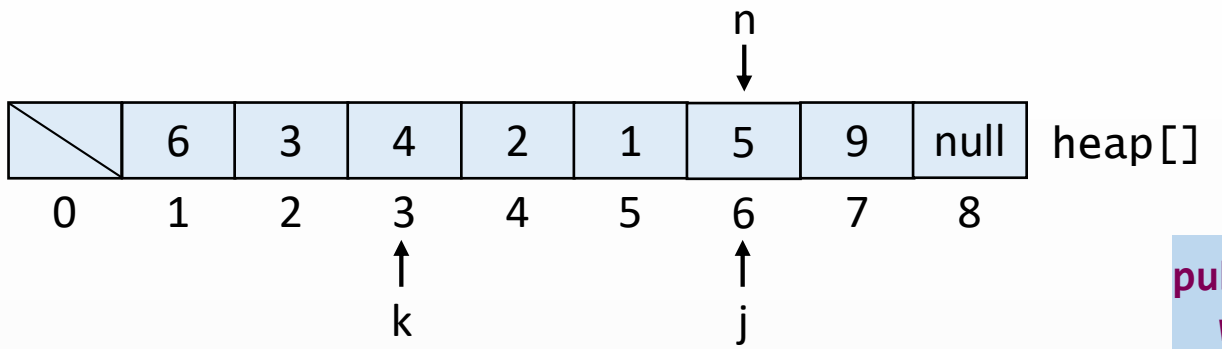



```
j = 6
k = 3
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

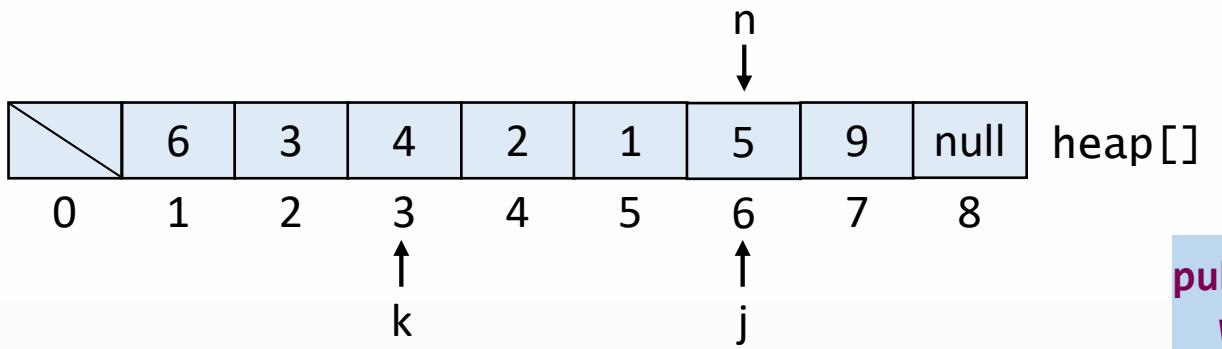


```
j = 6
k = 3
max = 9
n = 6


silMax()
```

```java
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```

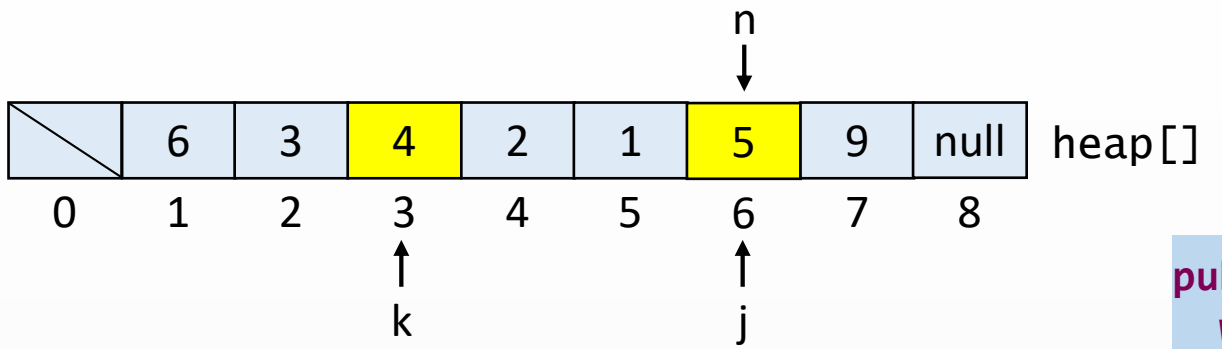


```
j = 6
k = 3
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```




```
j = 6
k = 3
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
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  int gecici = heap[a];
  heap[a] = heap[b];
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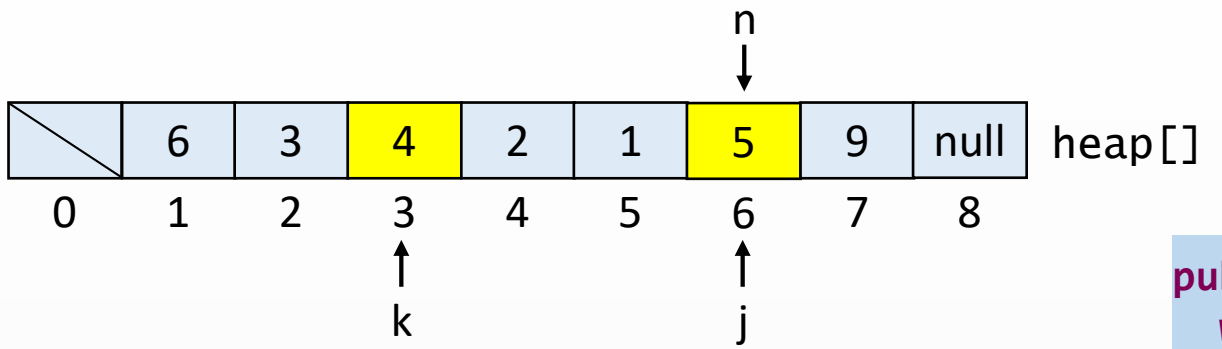
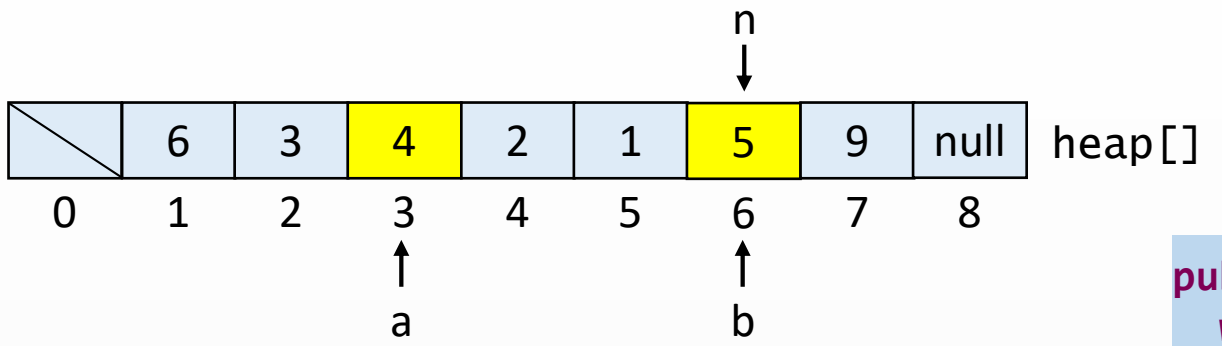



```
j = 6
k = 3
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```



```
b = 5
a = 4
j = 6
k = 3
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
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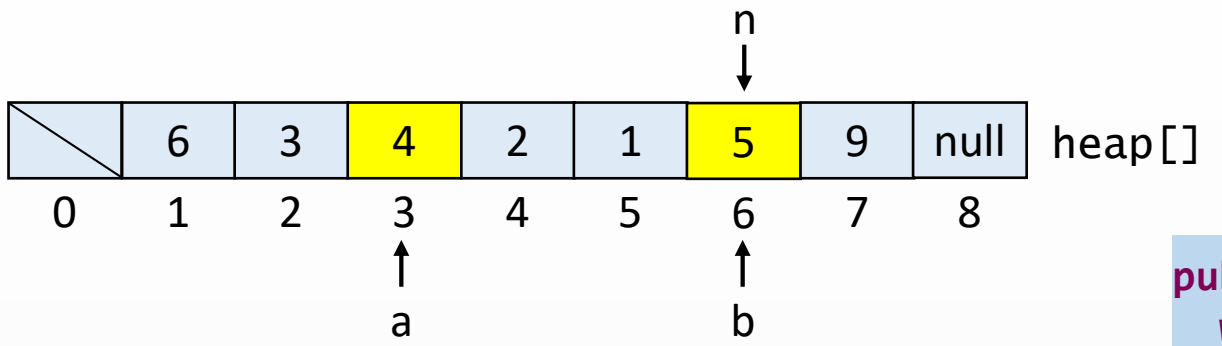
```



```
gecici = 4
b = 5
a = 4
j = 6
k = 3
max = 9
n = 6
```

```
silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
    if(j < n && heap[j] < heap[j+1]) {
      j++;
    }
    if(heap[k] >= heap[j]) {
      break;
    }
    yerDegistir(k, j);
    k = j;
  }
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public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
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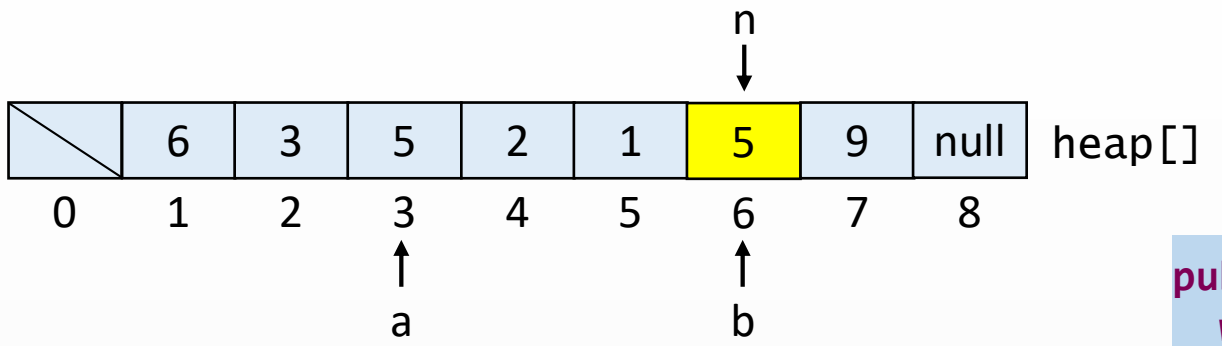
```



```
gecici = 4
b = 5
a = 4
j = 6
k = 3
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
    int j = 2*k;
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    }
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      break;
    }
    yerDegistir(k, j);
    k = j;
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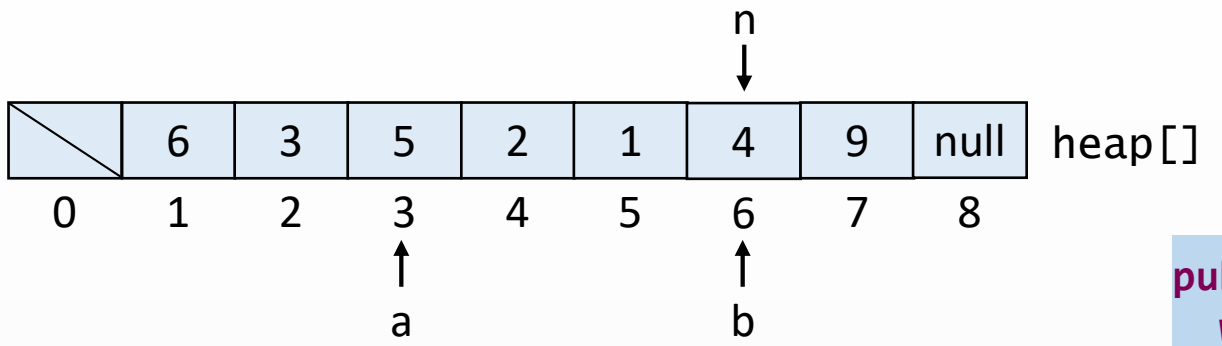

```
gecici = 4
b = 5
a = 4
j = 6
k = 3
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
  while(2*k <= n) {
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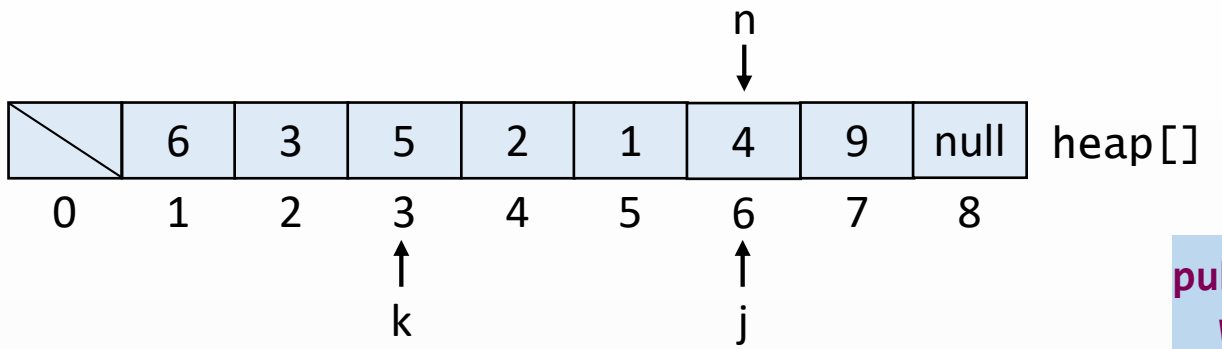

```
j = 6
k = 3
max = 9
n = 6


silMax()
```

```
public void batir(int k) {
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  int gecici = heap[a];
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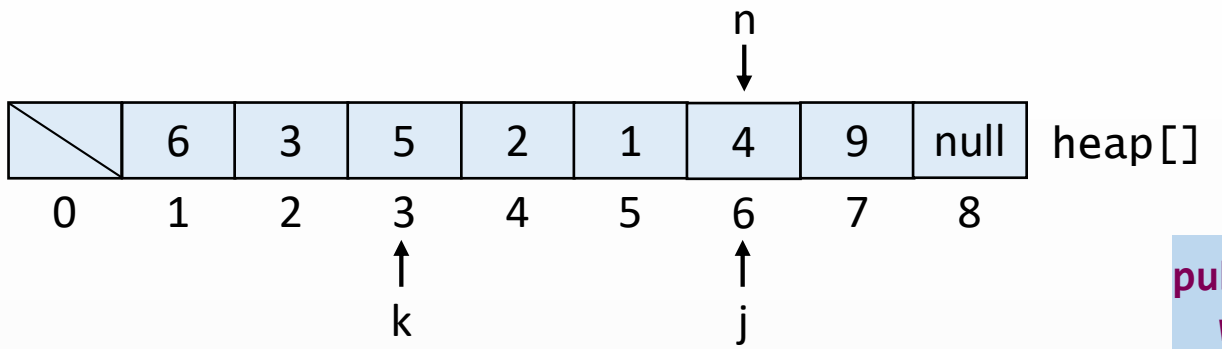

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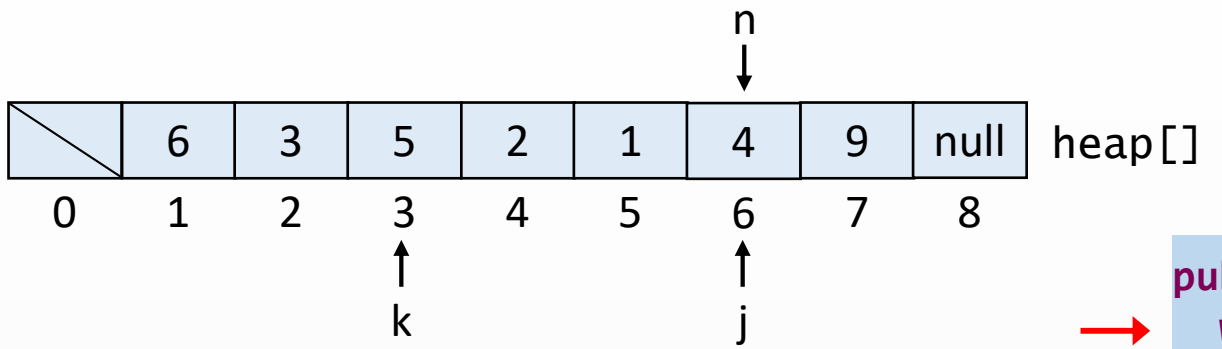

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```

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      j++;
    }
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    }
    yerDegistir(k, j);
    k = j;
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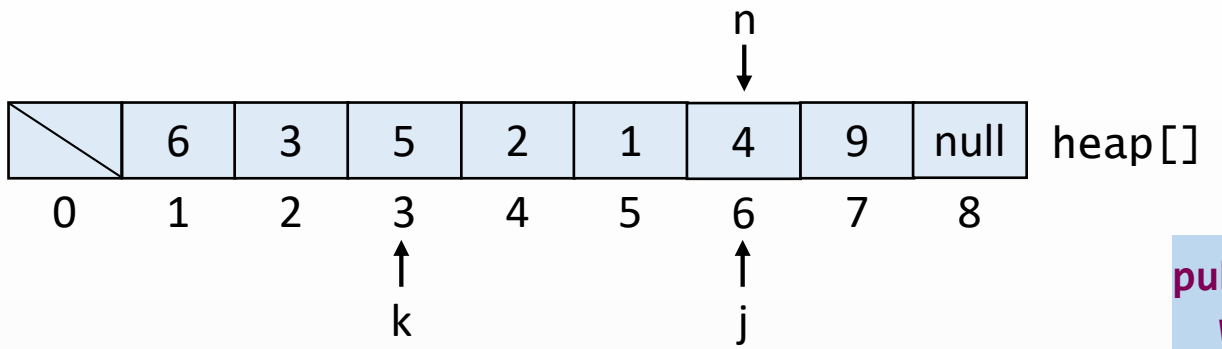


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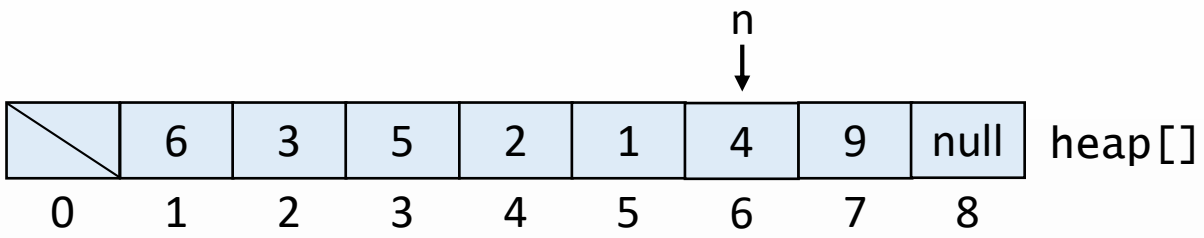
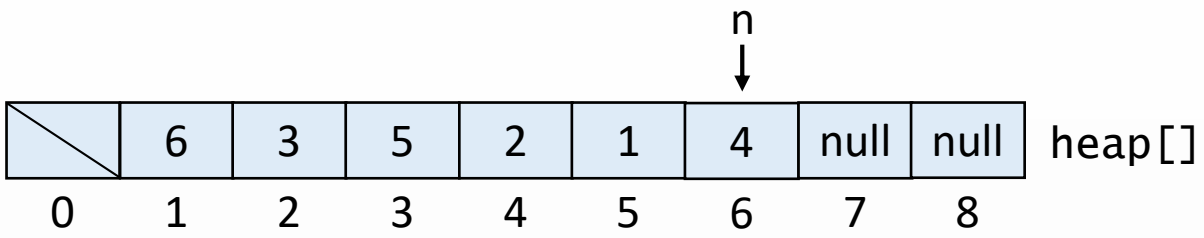


```
max = 9
n = 6


silMax()
```

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```



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max = 9
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silMax()
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  int max = heap[1];
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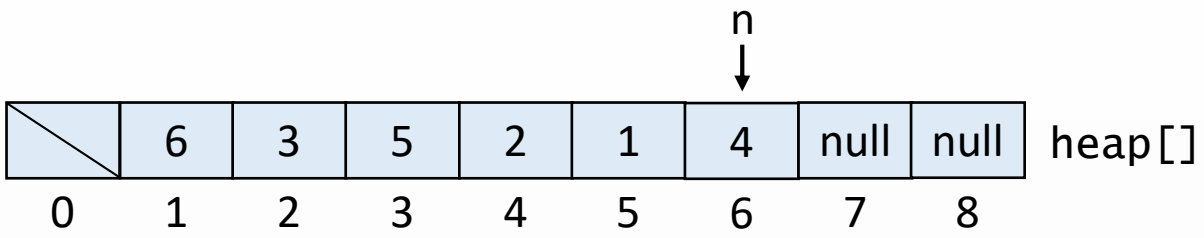

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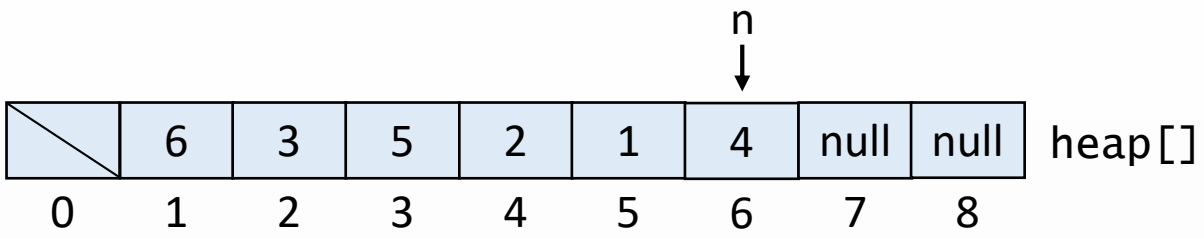

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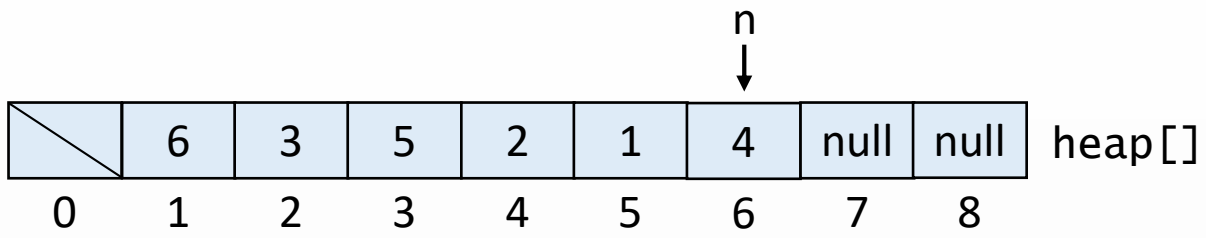

n = 6

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
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  heap[n + 1] = null;
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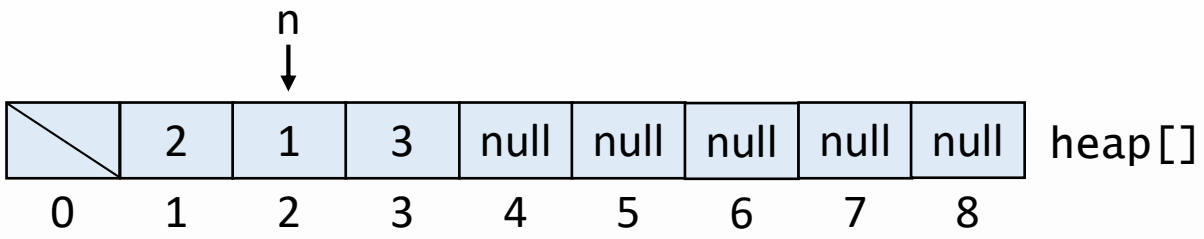
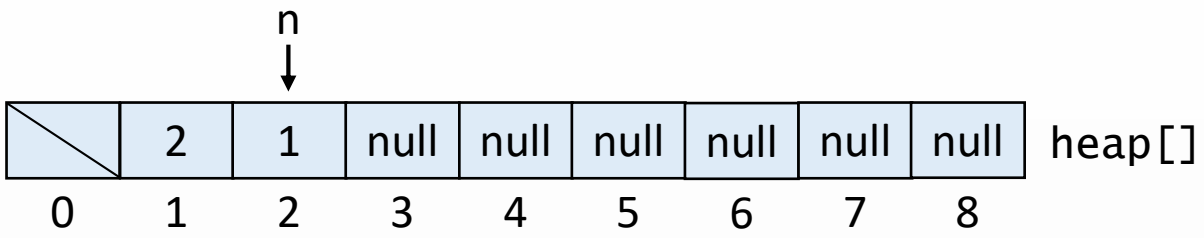


```
max = 3
n = 2
```

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
  heap[b] = gecici;
}
```



```
max = 3
n = 2
```

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
  n--;
  batir(1);
  heap[n + 1] = null;
  if(n > 0 && (n == (heap.length - 1) / 4)) {
    kucult(heap.length / 2);
  }
  return max;
}

public void yerDegistir(int a, int b) {
  int gecici = heap[a];
  heap[a] = heap[b];
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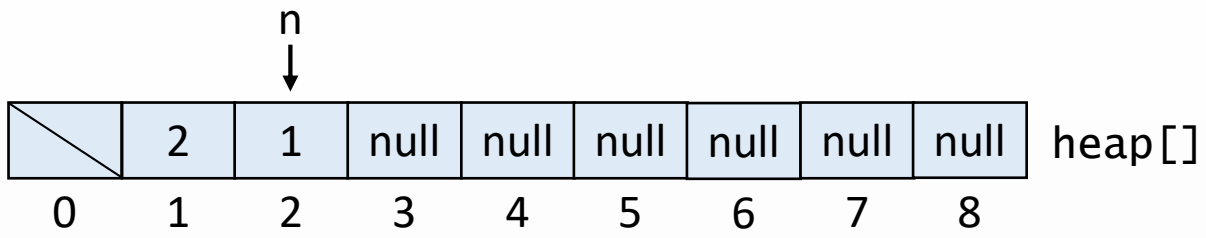
```



```
max = 3
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```
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  int max = heap[1];
  yerDegistir(1,n);
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  int gecici = heap[a];
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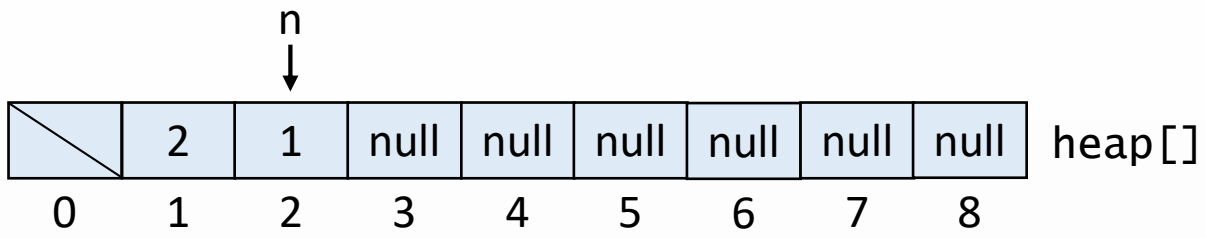
```



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max = 3
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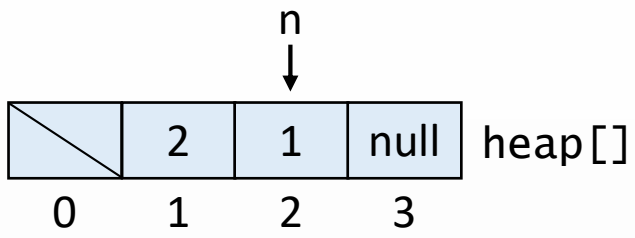

max = 3
n = 2

```
public int silMax() {
  int max = heap[1];
  yerDegistir(1,n);
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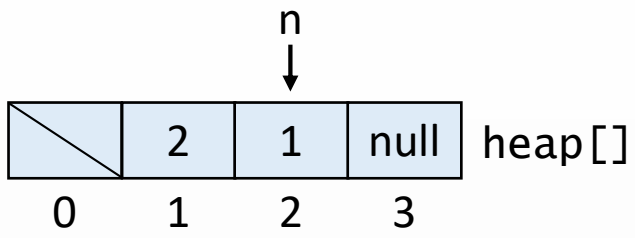

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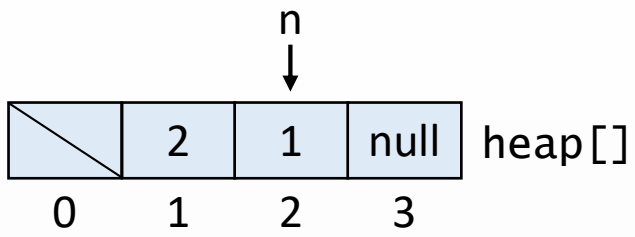

n = 2

```
public int silMax() {
  int max = heap[1];
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  n--;
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  heap[n + 1] = null;
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SON

Sercan KÜLCÜ, Tüm hakları saklıdır.