Quicksort
Et eksempel på rekursjon

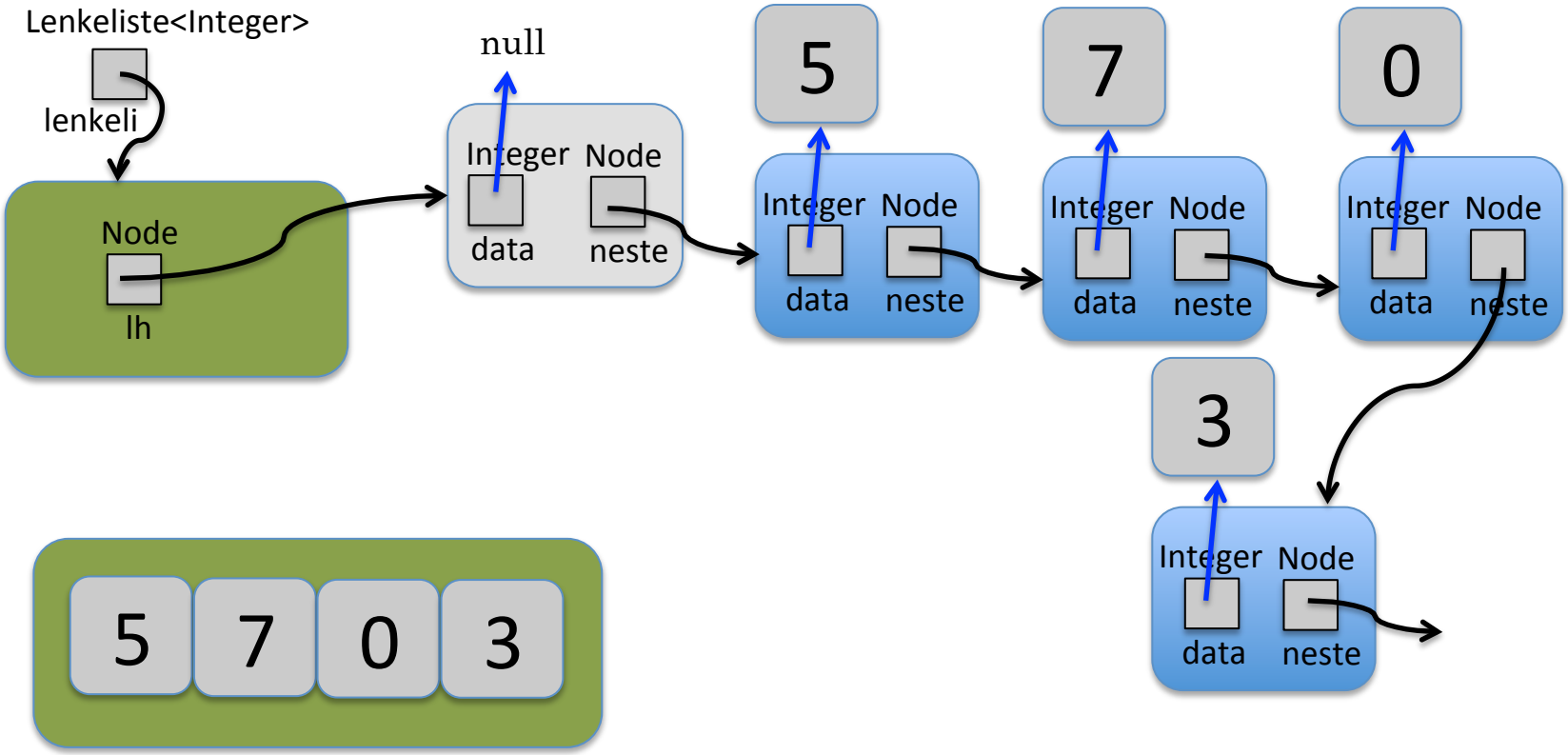
INF1010

Stein Michael Storleer

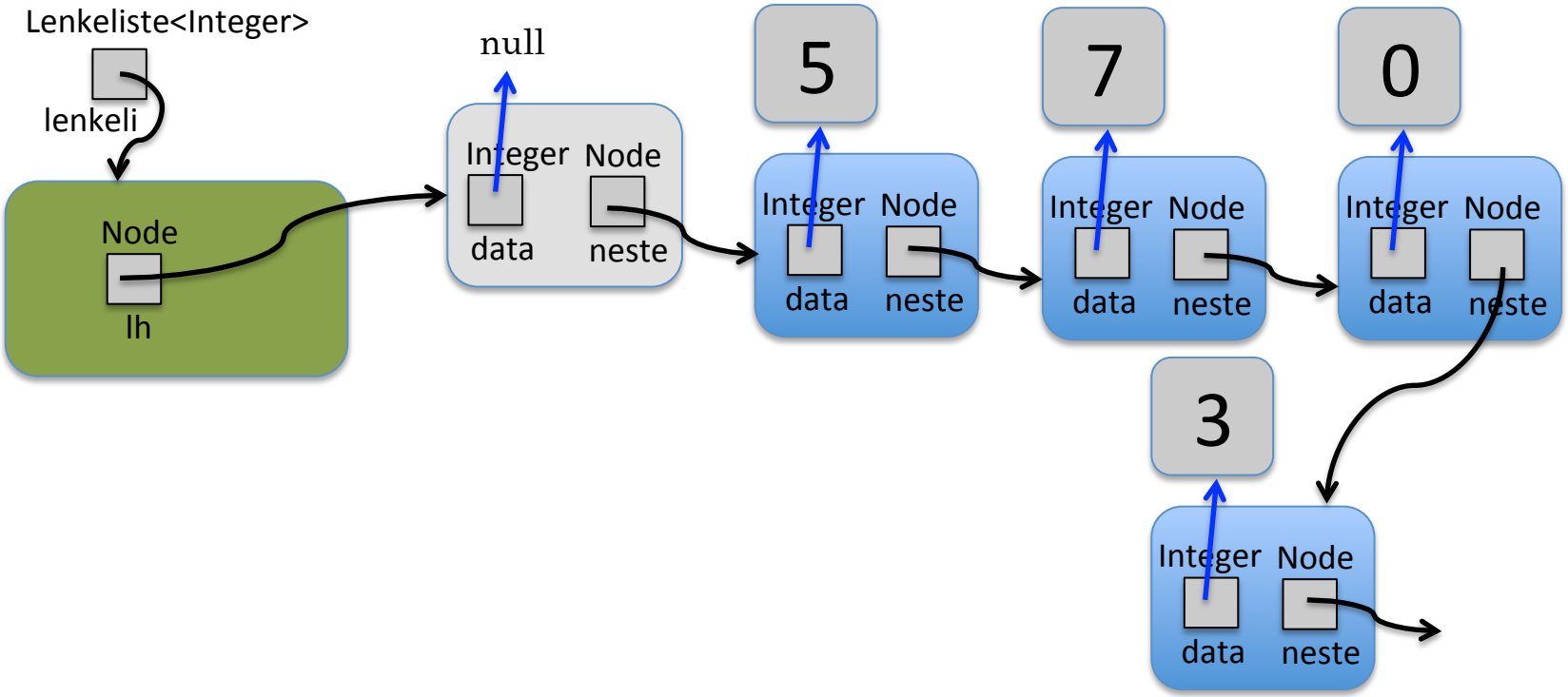

public static void quicksort(char[] items, int left, int right)
{
int i, j;
char x, y;
i = left; j = right;
x = items[(left + right) / 2];
do
{
while ((items[i] < x) && (i < right)) i++;
while ((x < items[j]) && (j > left)) j--;
if (i <= j)
{
y = items[i];
items[i] = items[j];
items[j] = y;
i++; j--;
}
} while (i <= j);
if (left < j) quicksort(items, left, j);
if (i < right) quicksort(items, i, right);
}

```
private static char[] quickSort(char[] items, int left, int right) {
        int L = left;
        int R = right;
        // we pick the middle item as comparand; other methods can be used as well.
        char comparand = items[(L + R) / 2];
        char comparated;

        do {
            while(items[L] < comparand && L < right) { L++; }
            while(comparand < items[R] && R > L) { R--; }

            if(L <= R) {
                comparated = items[L];
                items[L] = items[R];
                items[R] = comparated;
                L++;
                R--;
            }

        } while(L <= R);

        if(left < R) {
            quickSort(items, left, R);
        }
        if(L < right) {
            quickSort(items, L, right);
        }
        return items;
    }
}
```

https://en.wikibooks.org/wiki/Algorithm_Implementation/Sorting/Quicksort#Java




```
class Lenkeliste<T extends Comparable<T> > implements Iterable<T> {

    private Node lh = null ; // listehode
    private class Node { … }
    public void settInnForan(T o) { … }
    public T taUtForan() { … }

    public void quickSort() { … }
}
```




```
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    private Node lh = null ; // listehode
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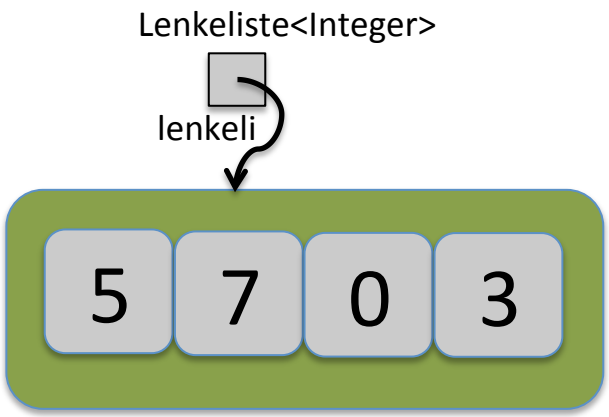


```
class Lenkeliste<T extends Comparable<T> > implements Iterable<T> {

    private Node lh = null ; // listehode
    private class Node { … }
    public void settInnForan(T o) { … }
    public T taUtForan() { … }

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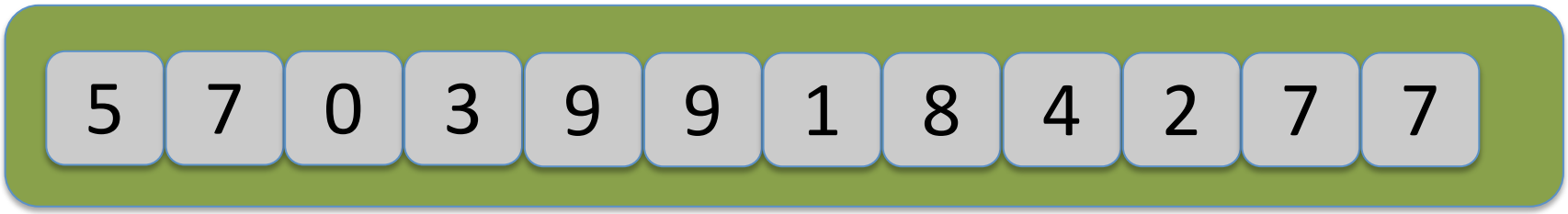
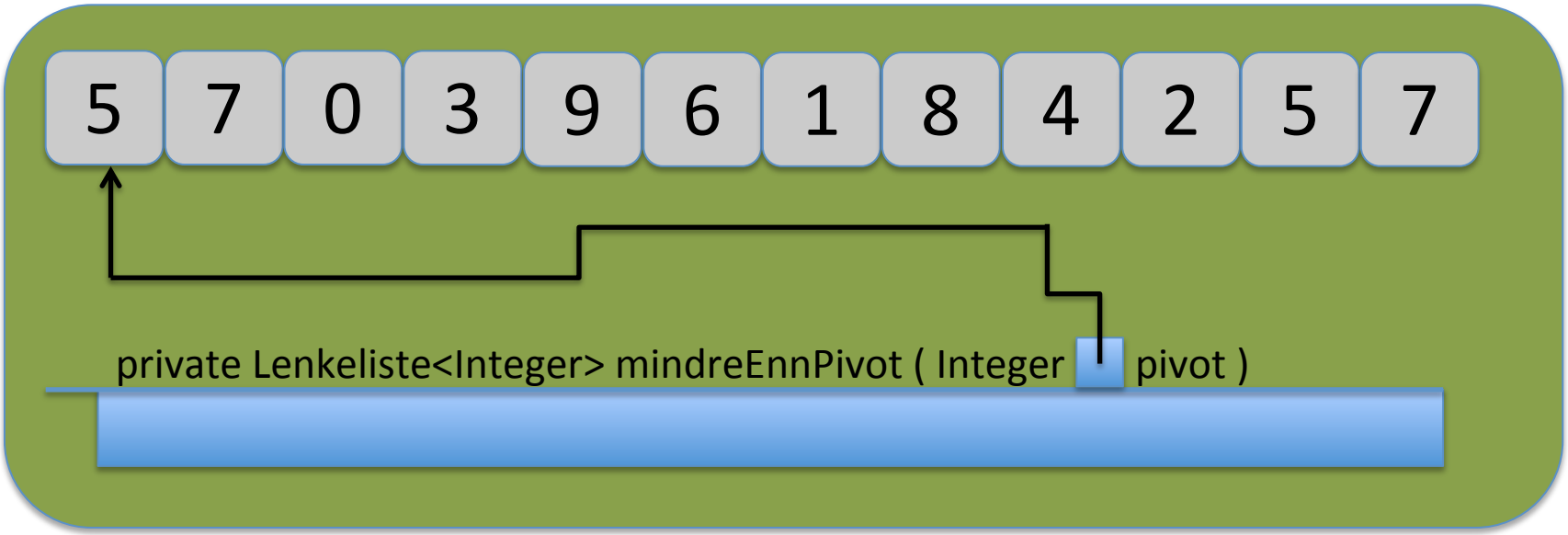
}
```


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


```
public void quickSort() {
    if (! tom() ) {
        T pivot = this.taUtForan();
        Lenkeliste<T> mep = mindreEnnPivot(pivot);
        …
}
```

```
private Lenkeliste<Integer> mindreEnnPivot ( Integer  pivot )
```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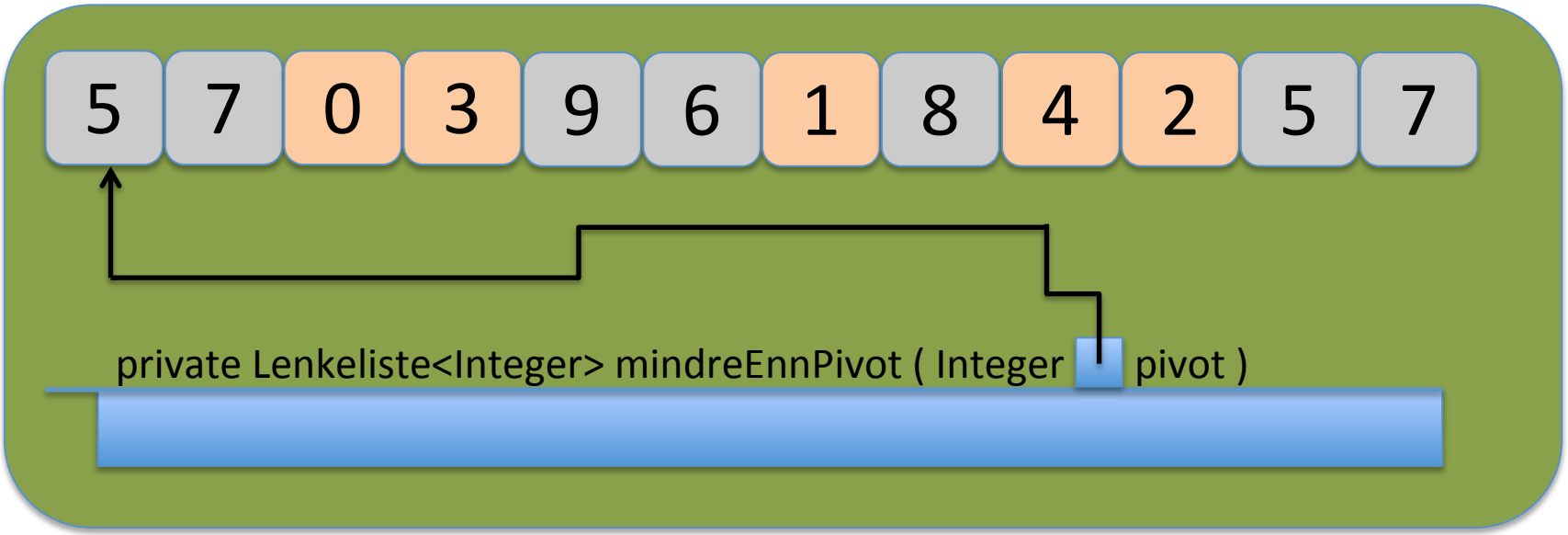
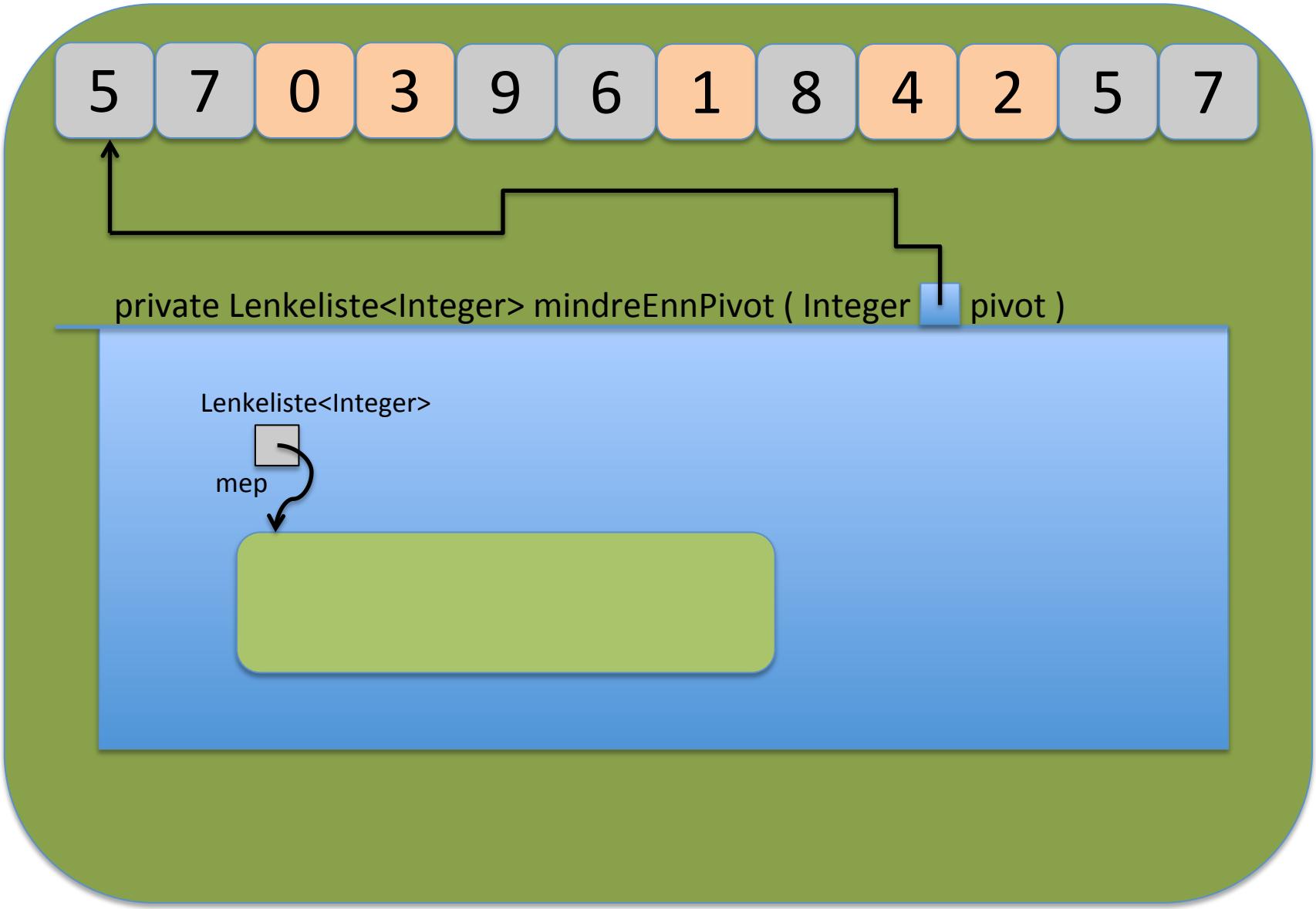
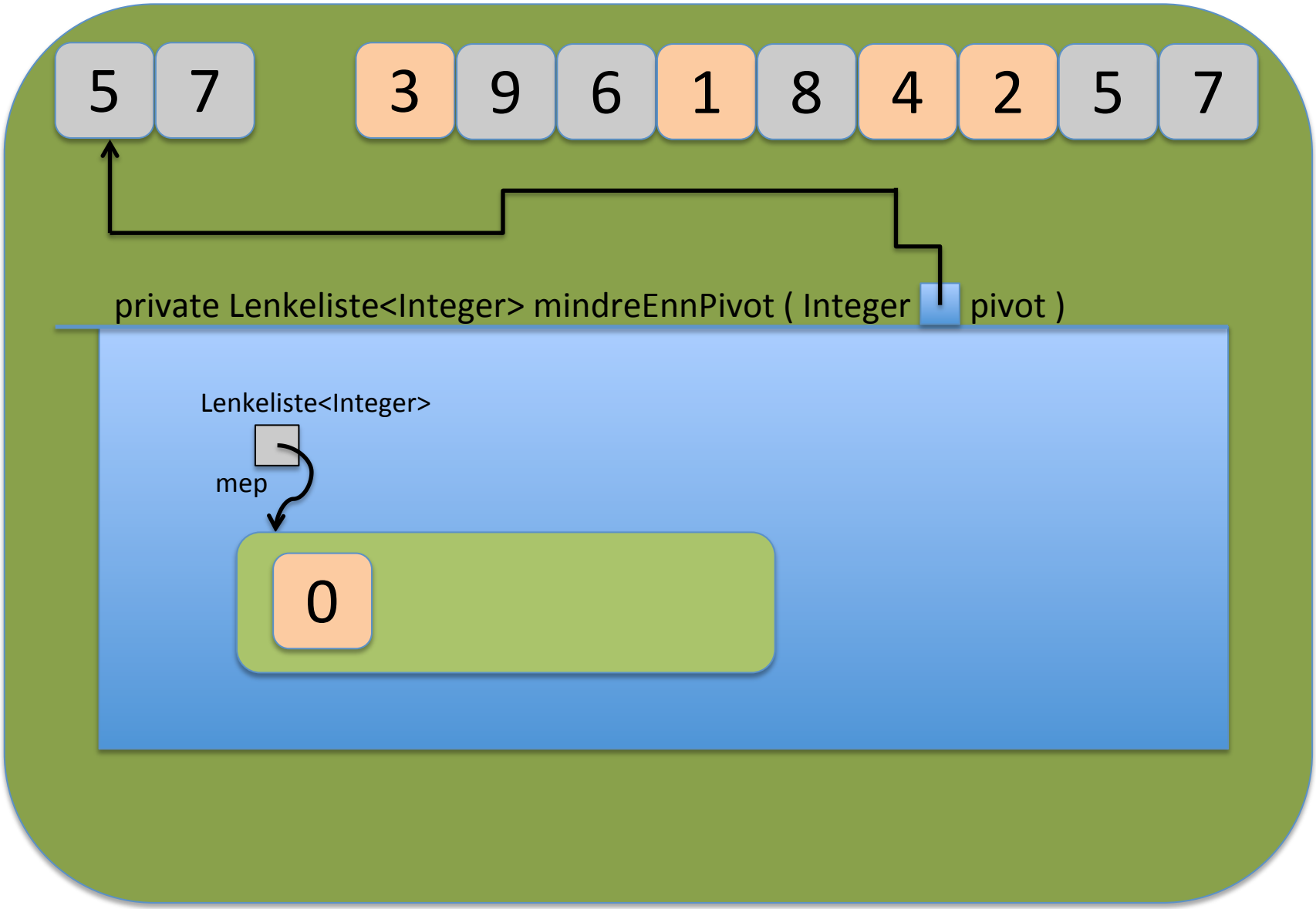
private Lenkeliste<Integer> mindreEnnPivot (Integer pivot)


5 7 0 3 9 6 1 8 4 2 5 7
private Lenkeliste<Integer> mindreEnnPivot (Integer pivot)


5 7 0 3 9 6 1 8 4 2 5 7
private Lenkeliste<Integer> mindreEnnPivot (Integer pivot)
Lenkeliste<Integer>
mep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private Lenkeliste<Integer> mindreEnnPivot (Integer pivot)
Lenkeliste<Integer>
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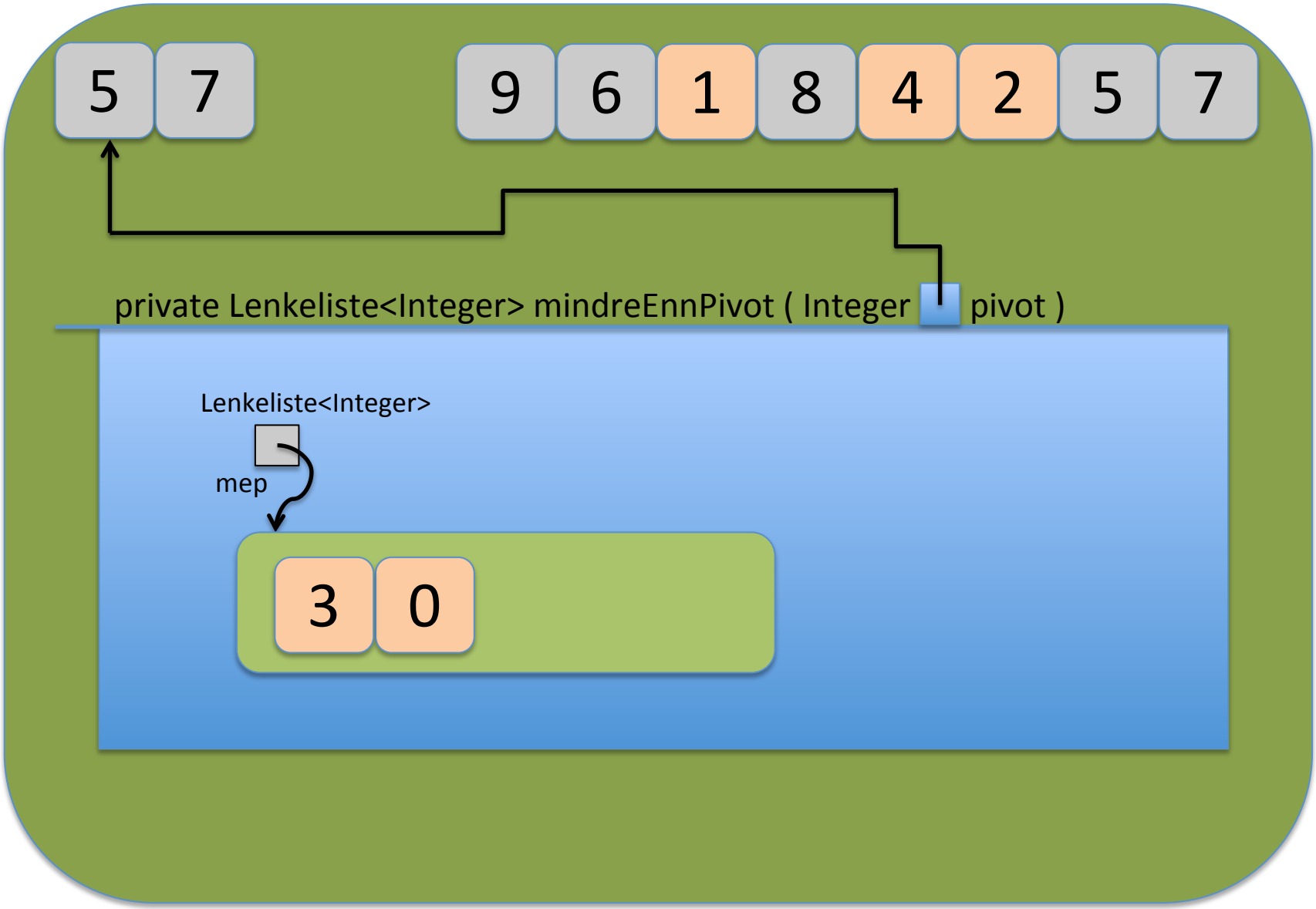
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private Lenkeliste<Integer> mindreEnnPivot (Integer
pivot)
Lenkeliste<Integer>
mep
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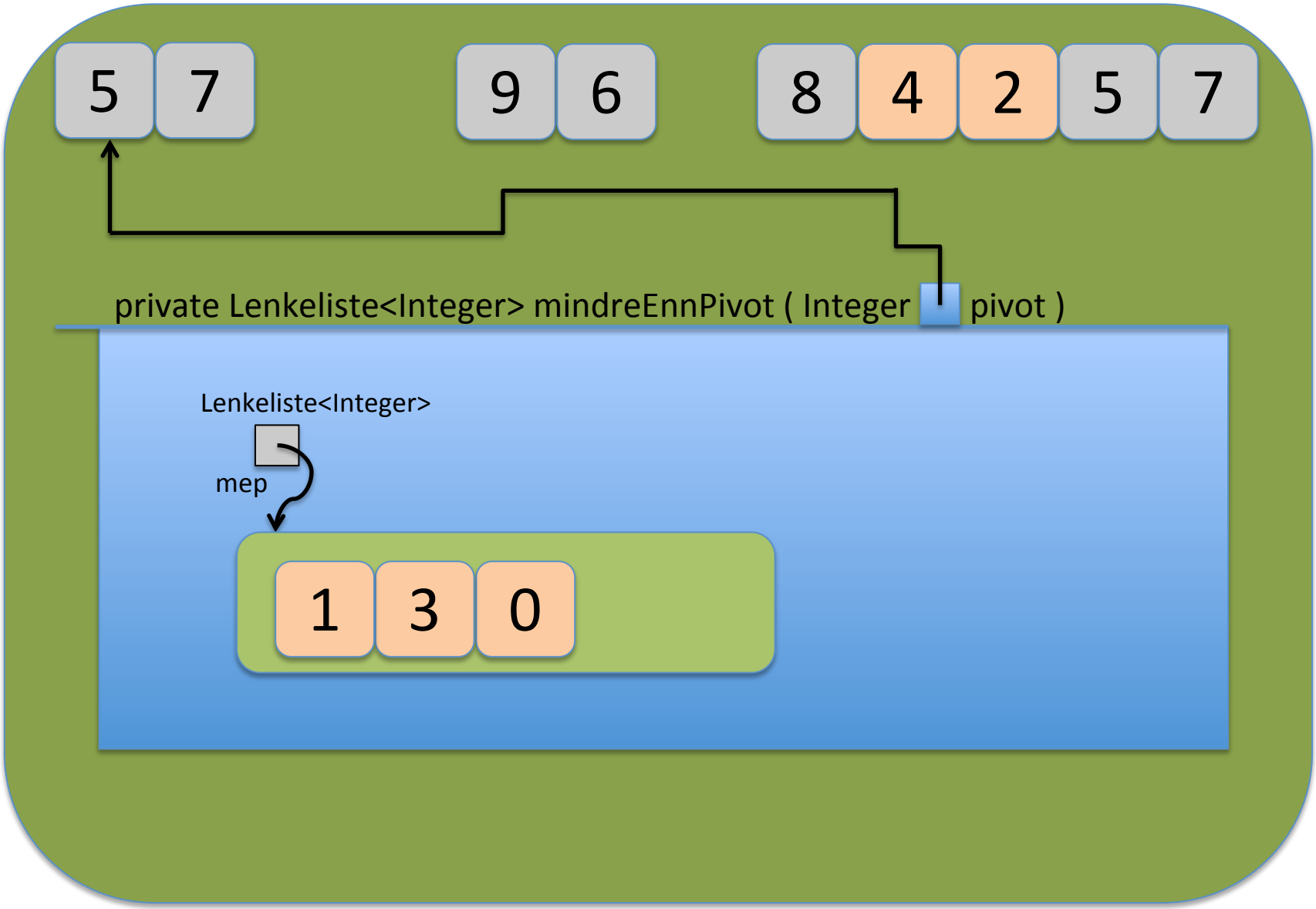
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private Lenkeliste<Integer> mindreEnnPivot (Integer pivot)
Lenkeliste<Integer>
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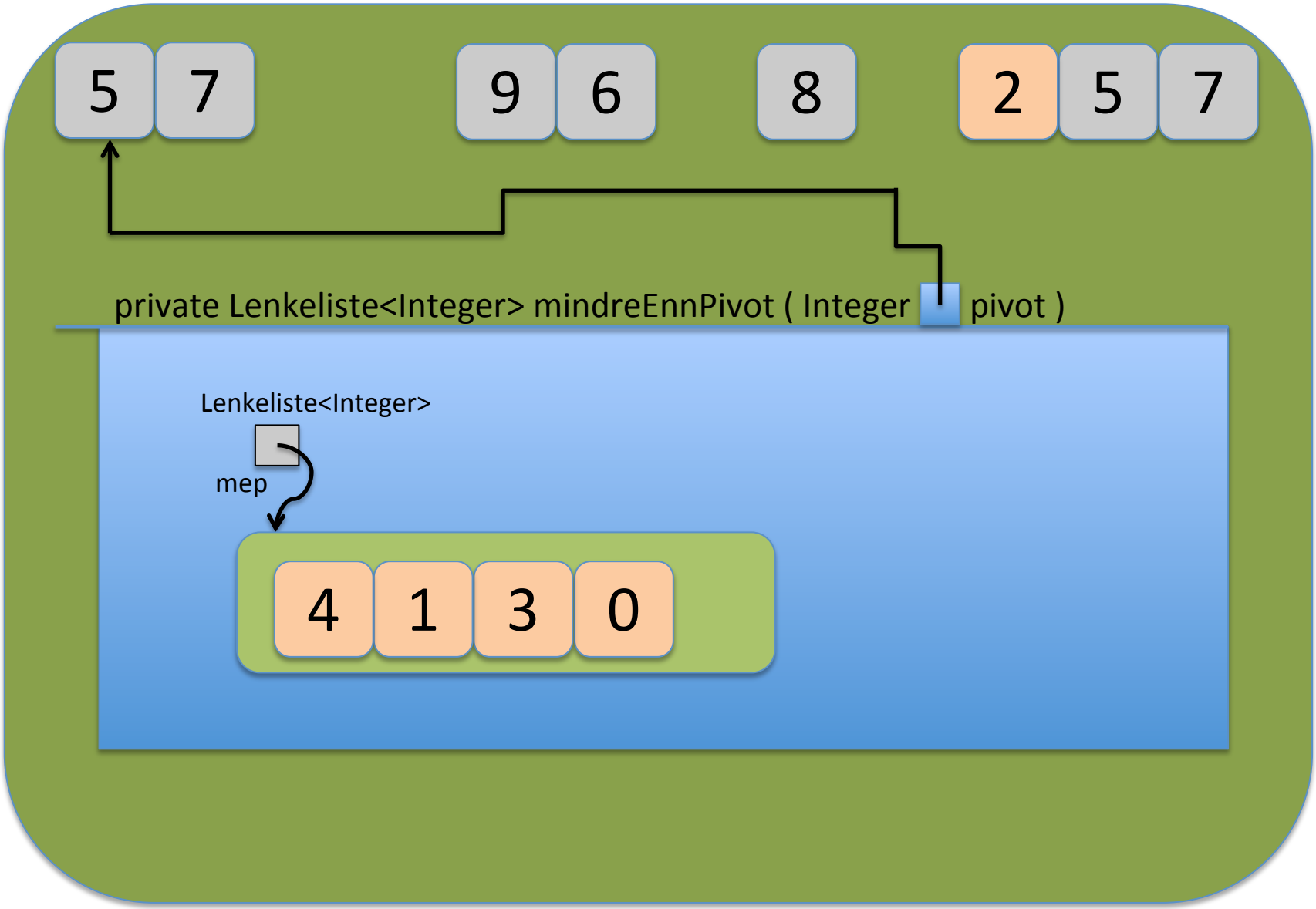
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Lenkeliste<Integer>
mep
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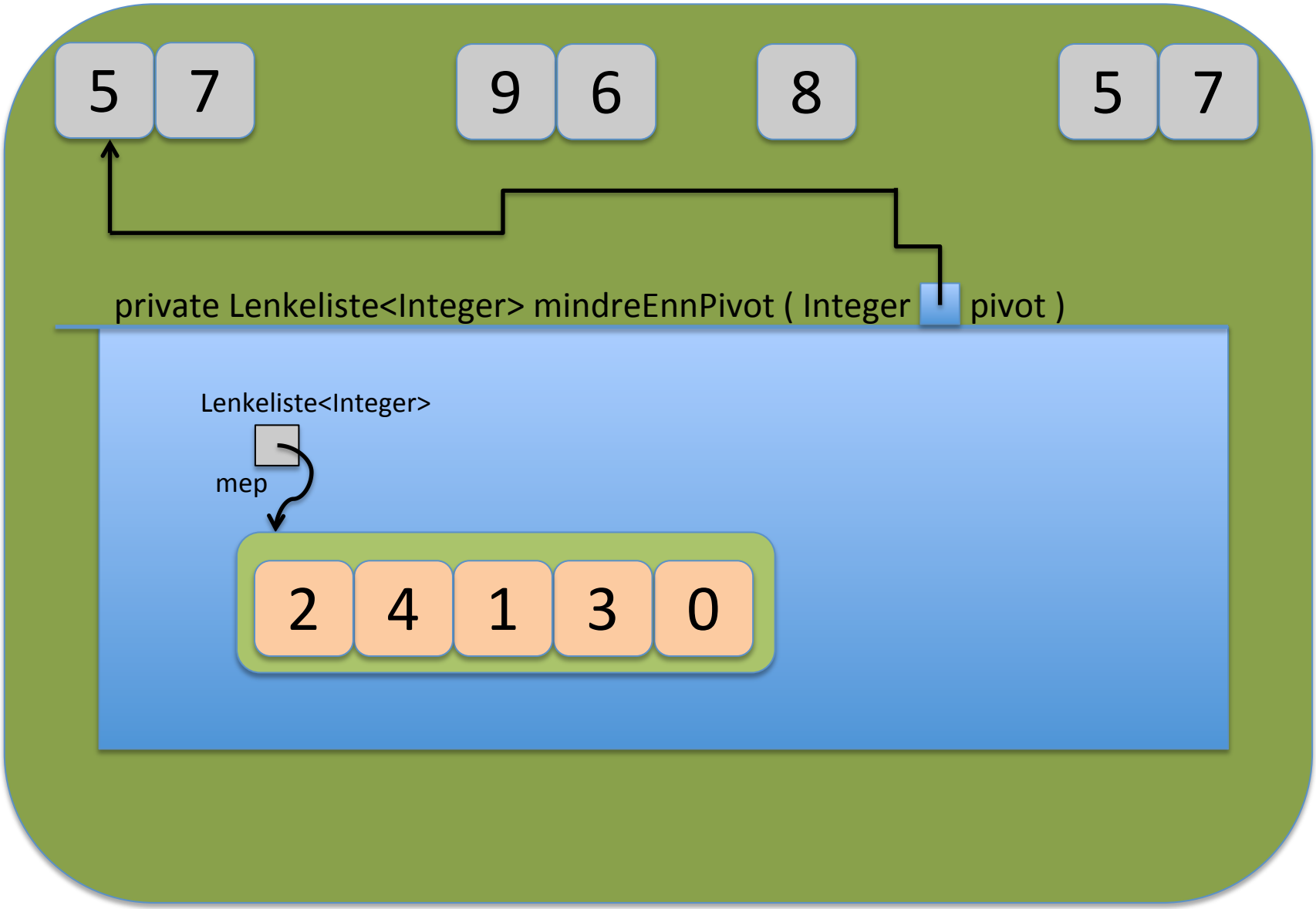
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private Lenkeliste<Integer> mindreEnnPivot (Integer pivot)
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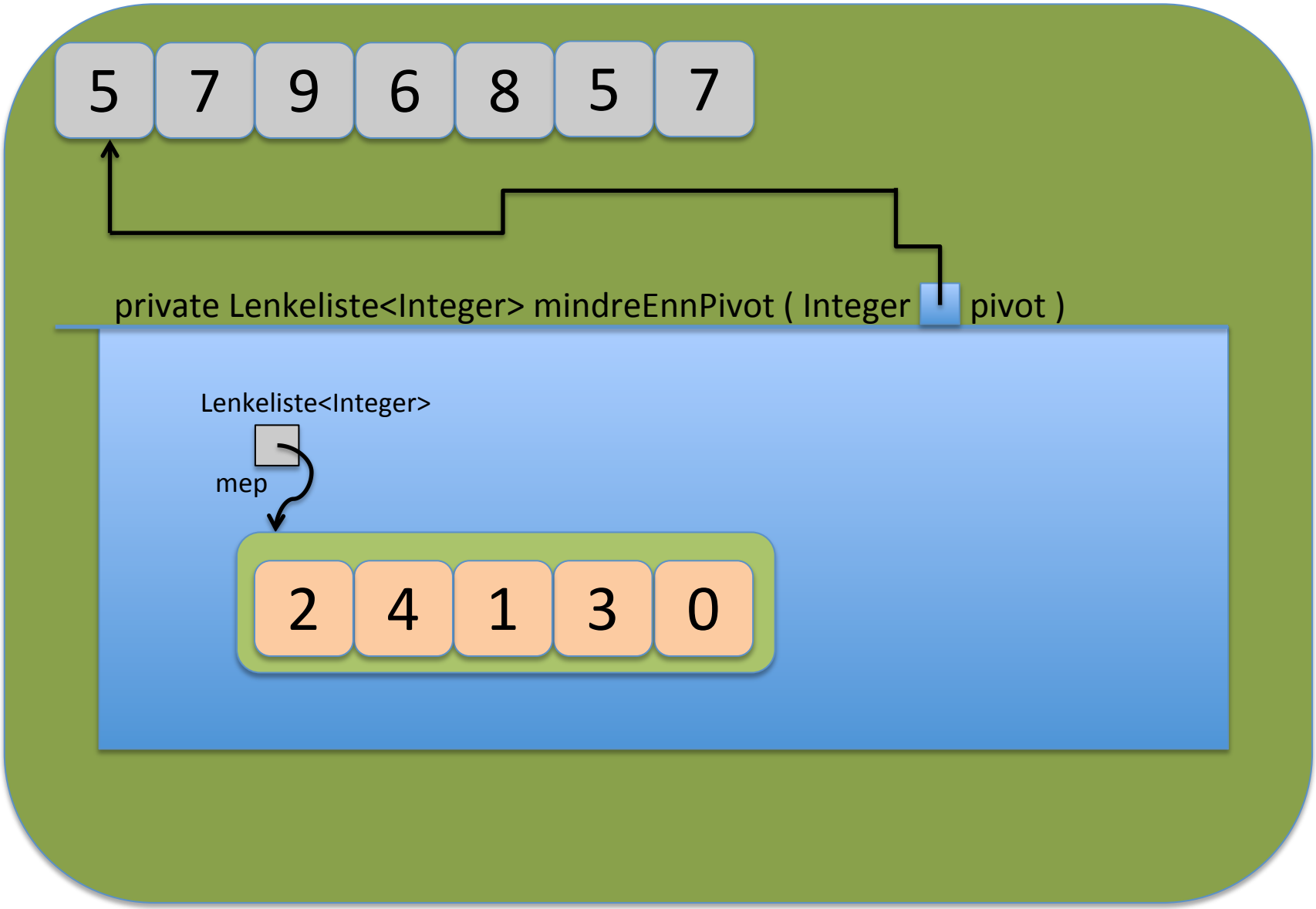
5 7 9 6 8 5 7
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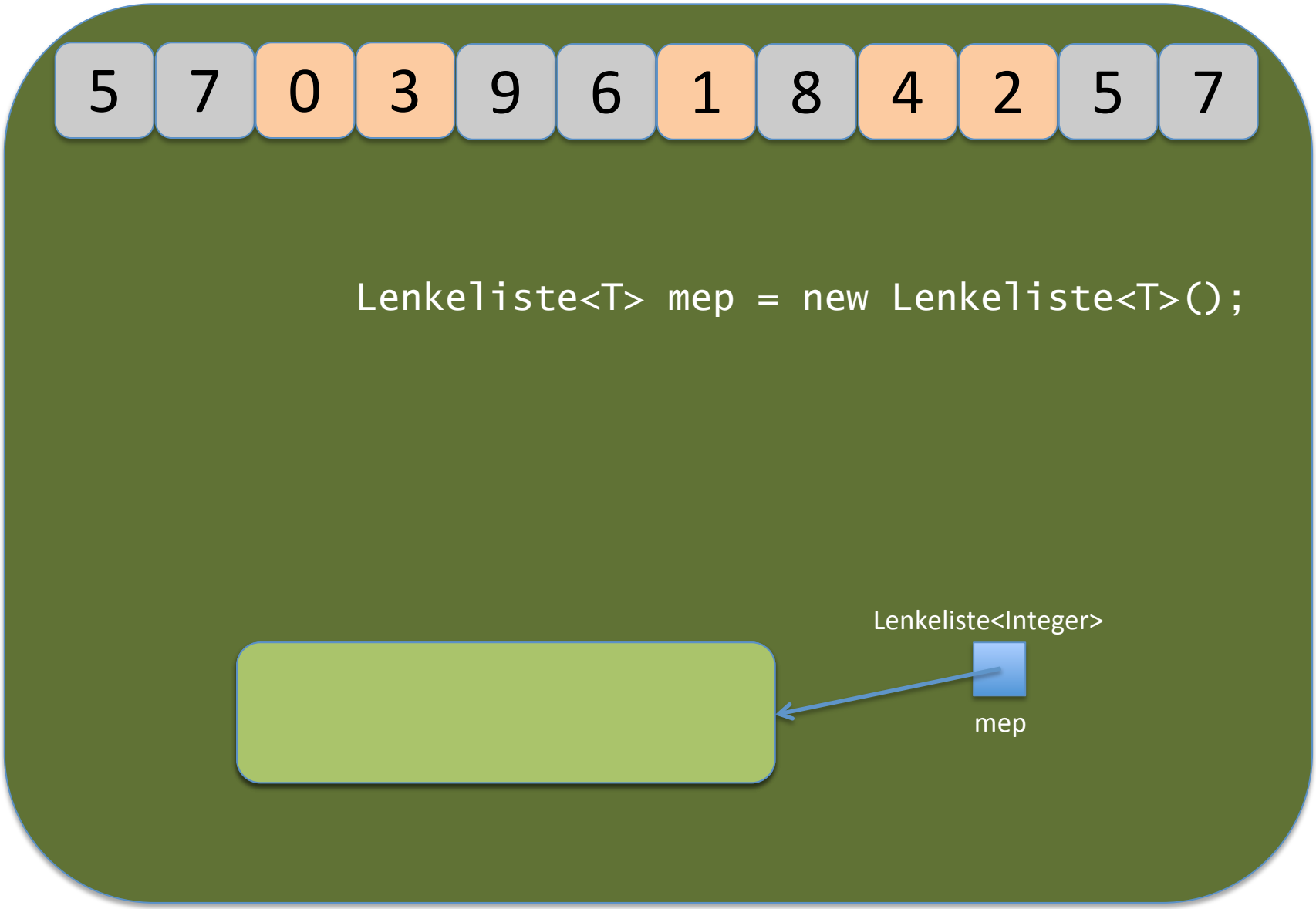
2 4 1 3 0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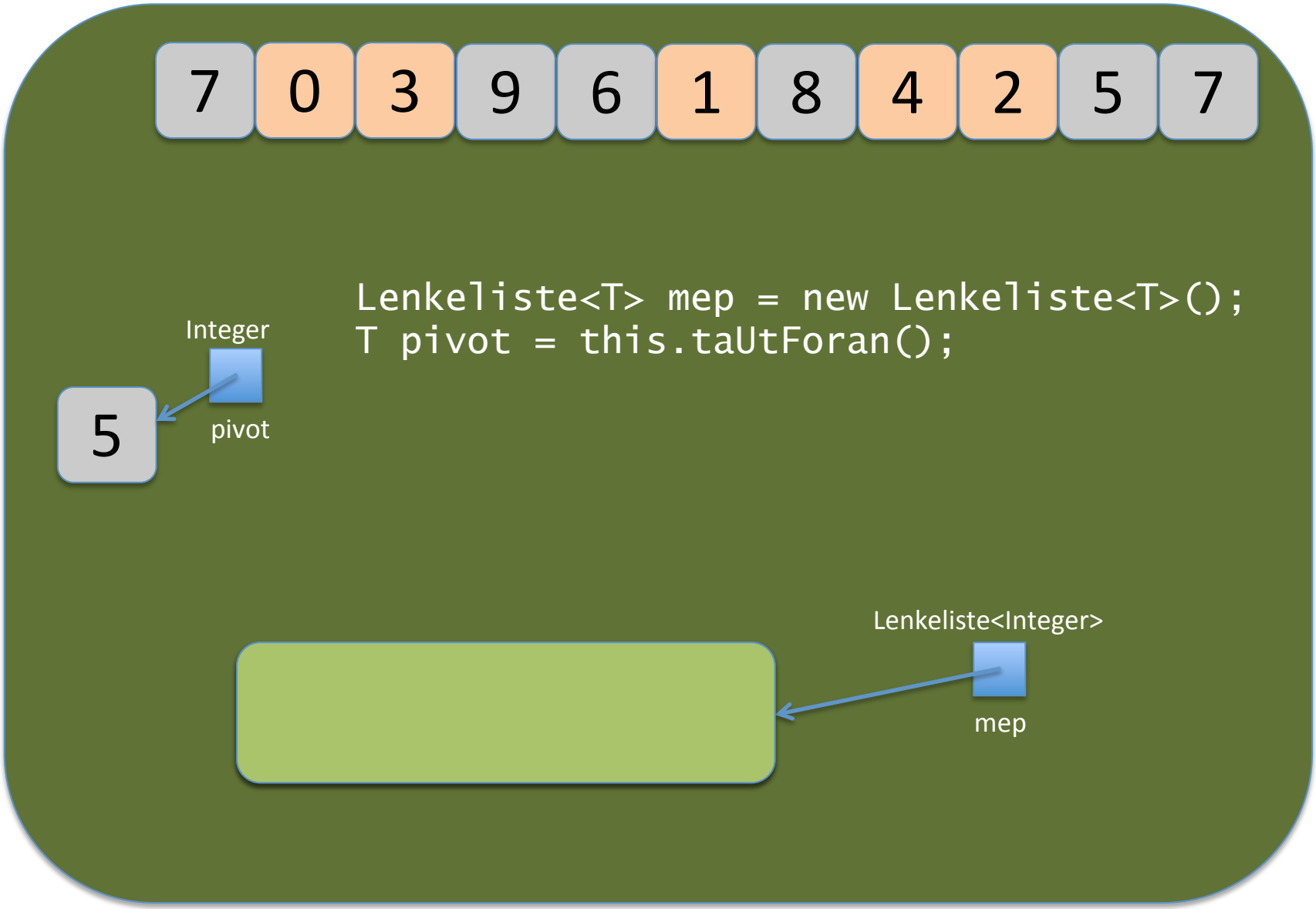
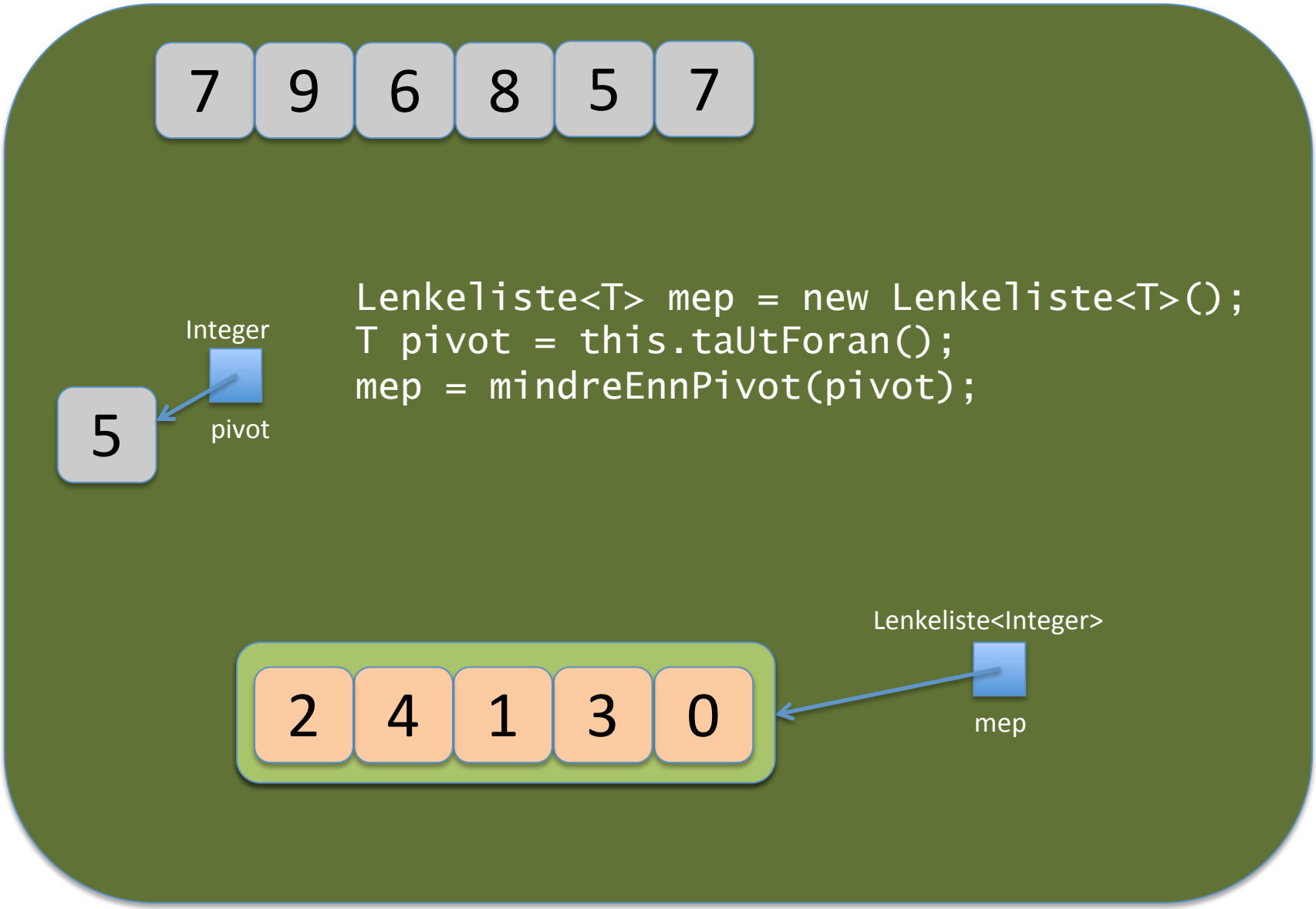
Lenkeliste<T> mep = new Lenkeliste<T>();
Lenkeliste<Integer>
mep


7 0 3 9 6 1 8 4 2 5 7
Lenkeliste<T> mep = new Lenkeliste<T>();
T pivot = this.taUtForan();
Integer
5
pivot
Lenkeliste<Integer>
mep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Integer
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pivot
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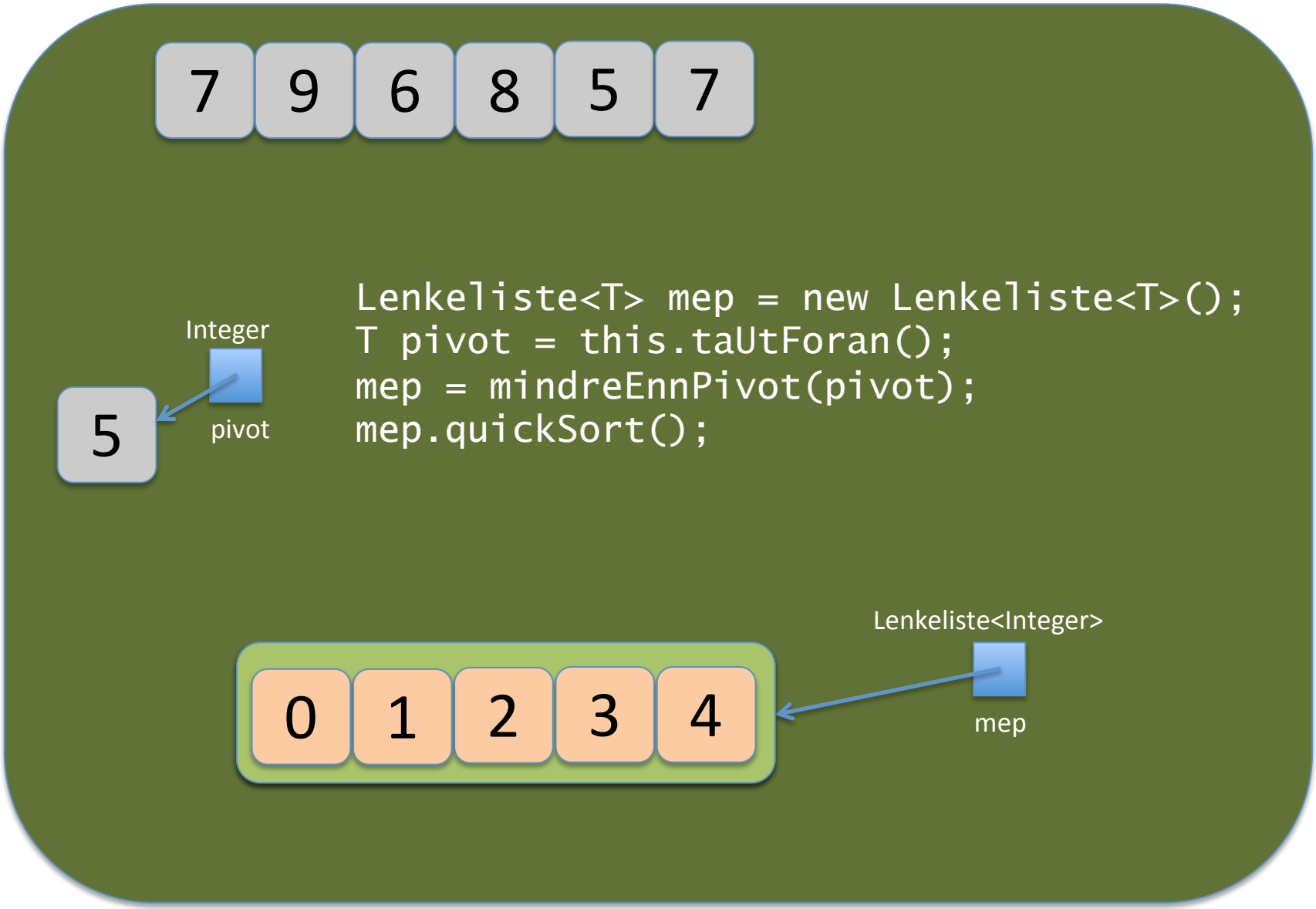
T pivot = this.taUtForan();
mep = mindreEnnPivot(pivot);
Lenkeliste<Integer>
2 4 1 3 0
mep


7 9 6 8 5 7
Integer
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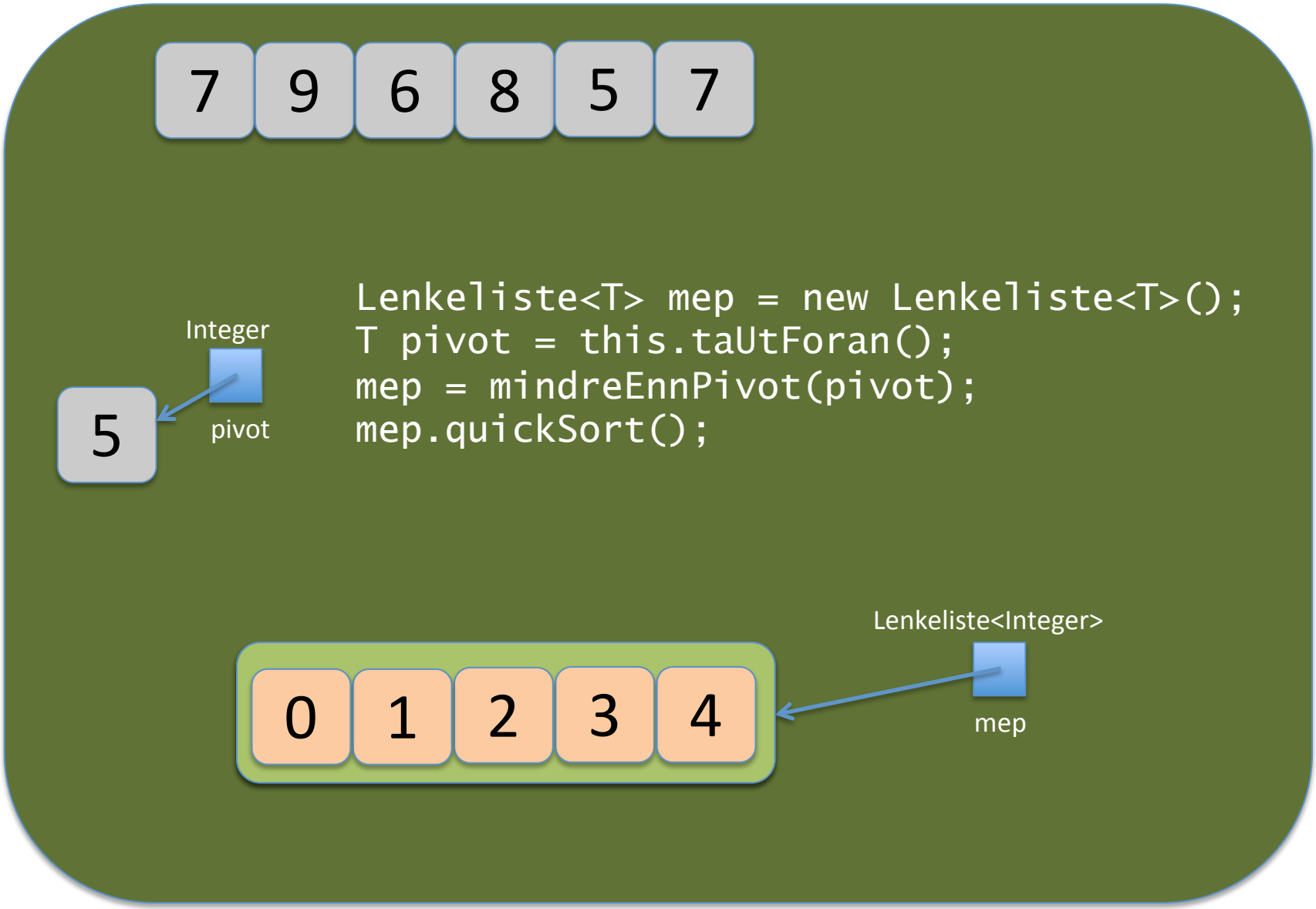
pivot
Lenkeliste<T> mep = new Lenkeliste<T>();
T pivot = this.taUtForan();
mep = mindreEnnPivot(pivot);
mep.quickSort();
Lenkeliste<Integer>
0 1 2 3 4
mep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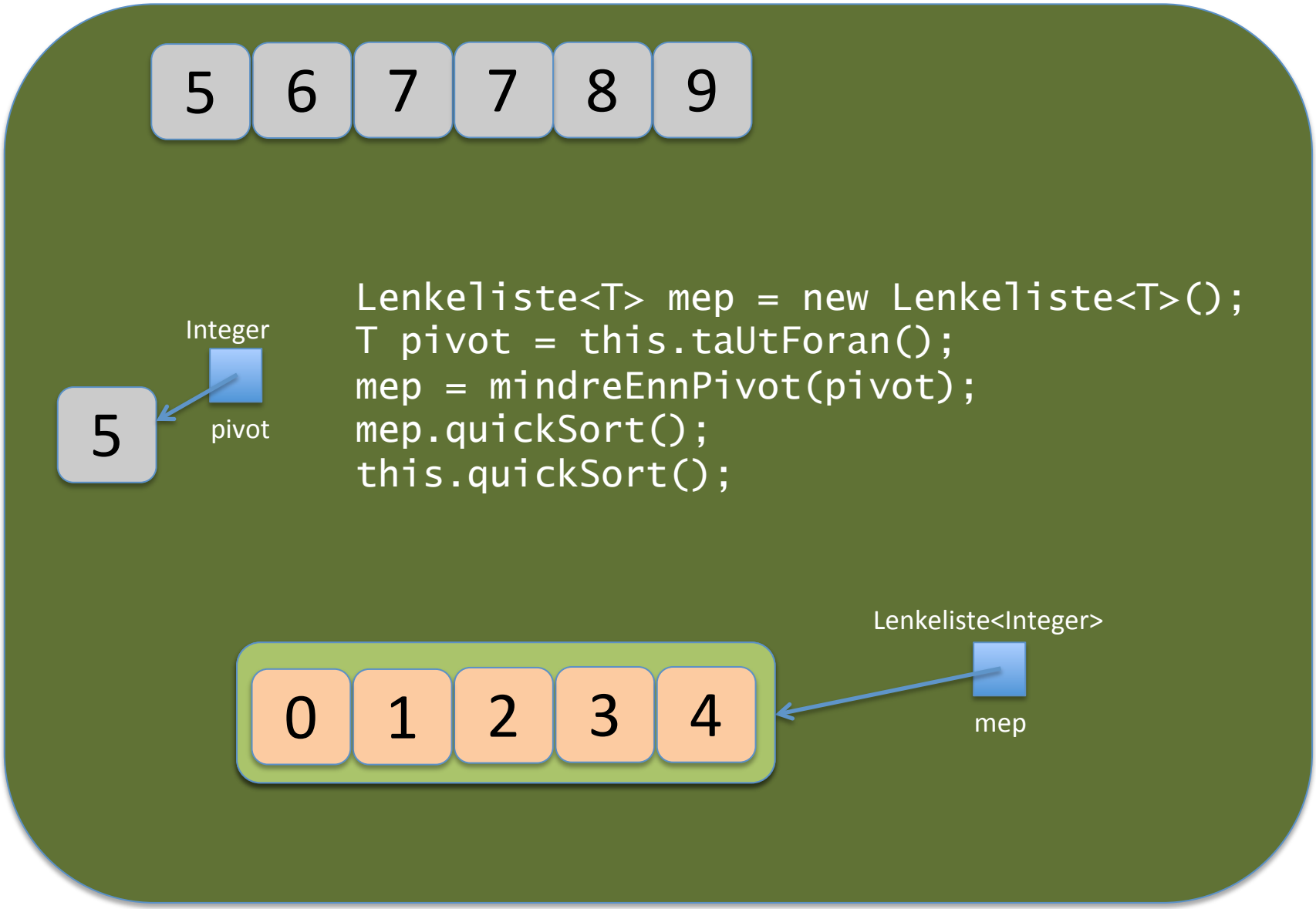
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Integer
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pivot
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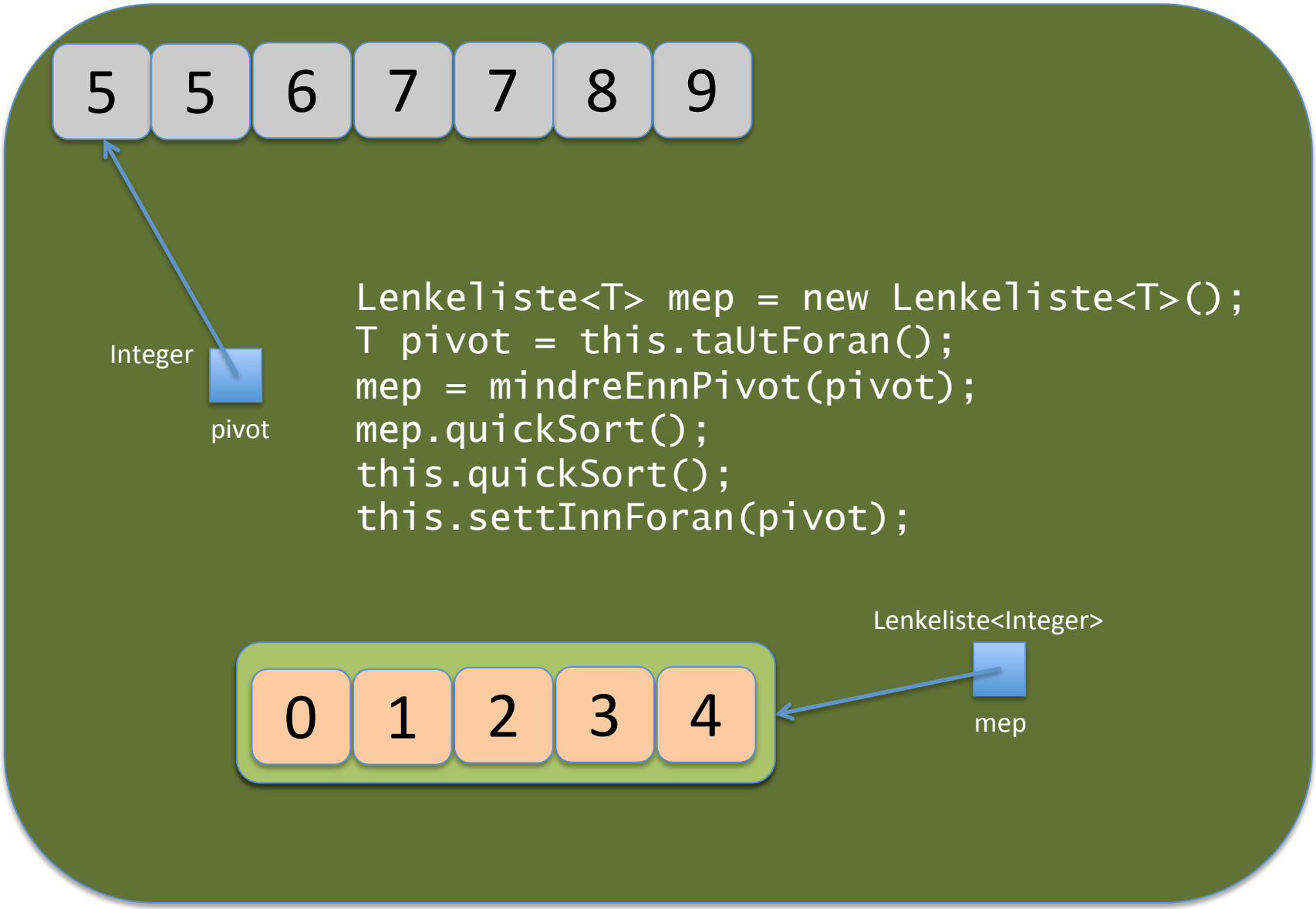
mep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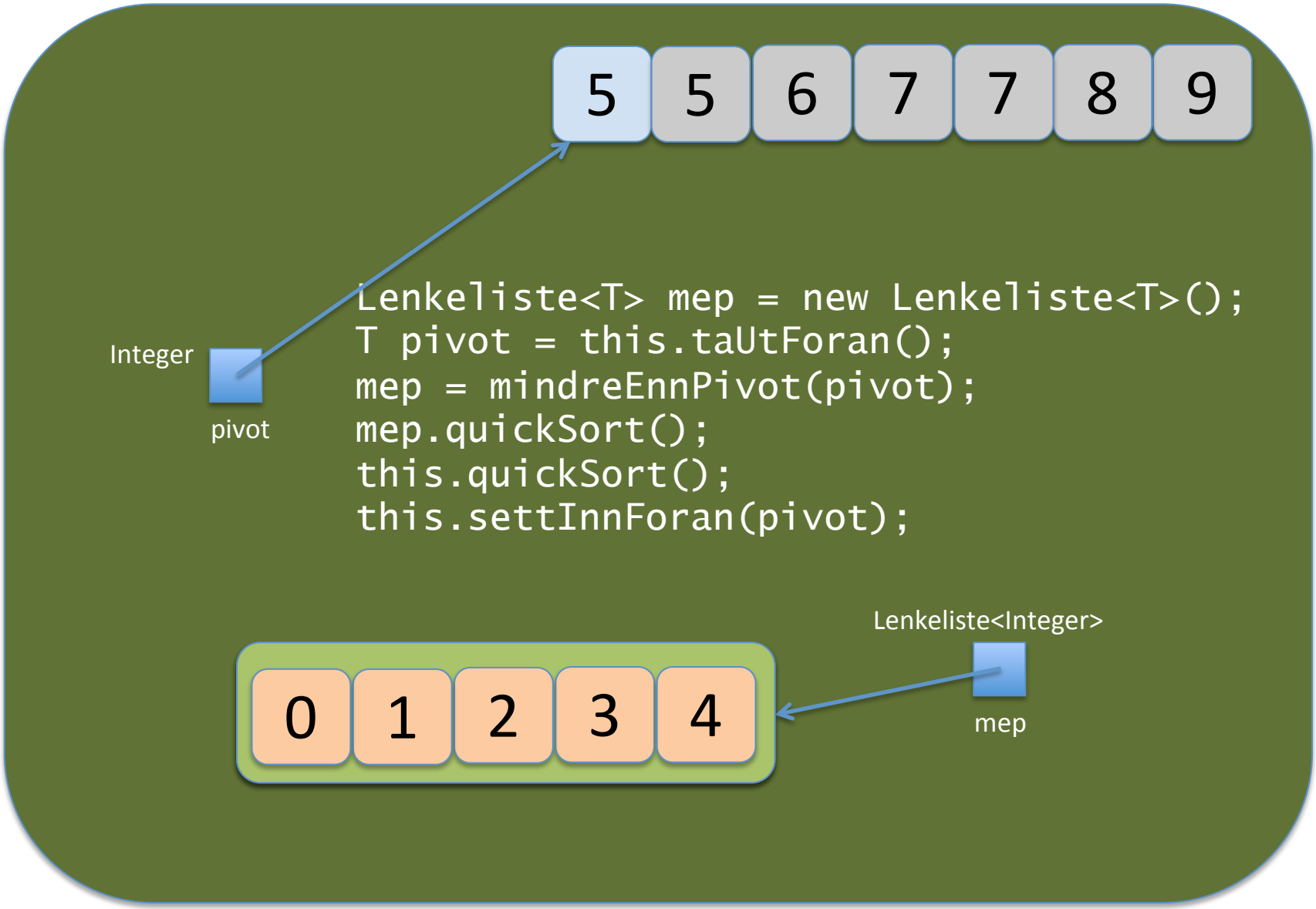
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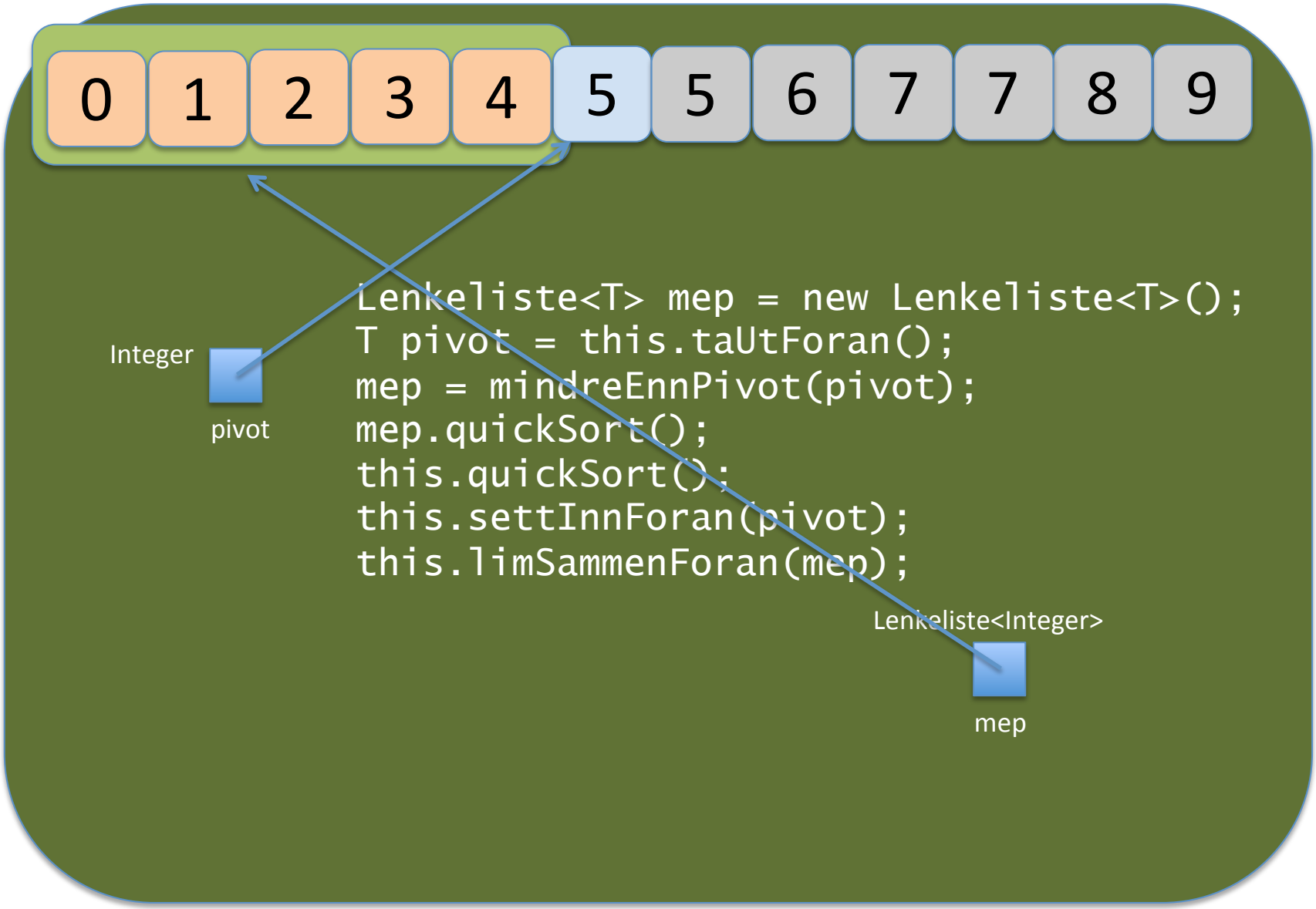
mep


0 1 2 3 4 5 5 6 7 7 8 9
Integer
pivot
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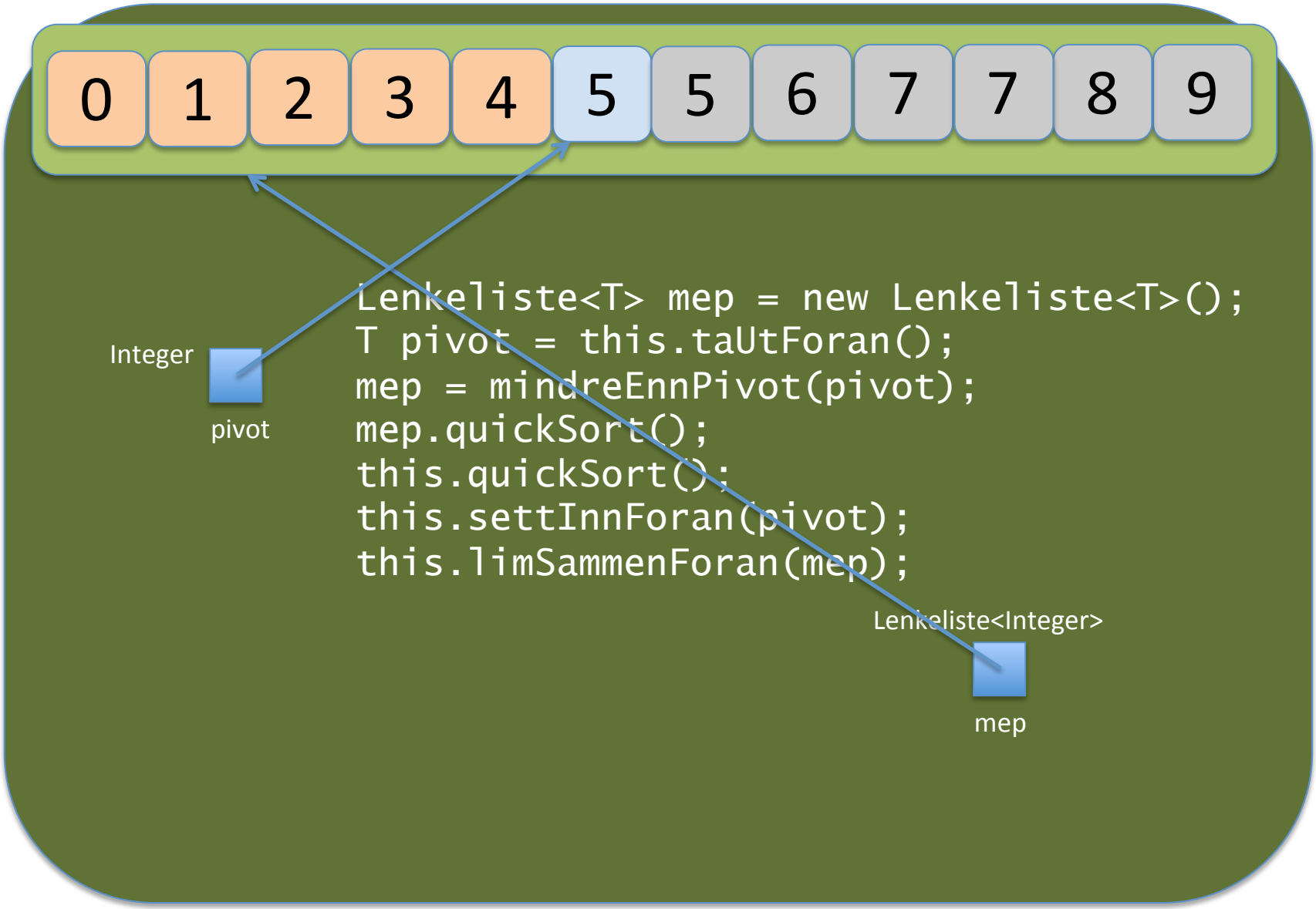
T pivot = this.taUtForan();
mep = mindreEnnPivot(pivot);
mep.quickSort();
this.quickSort();
this.settInnForan(pivot);
this.limSammenForan(mep);
Lenkeliste<Integer>
mep


0 1 2 3 4 5 5 6 7 7 8 9
Integer
pivot
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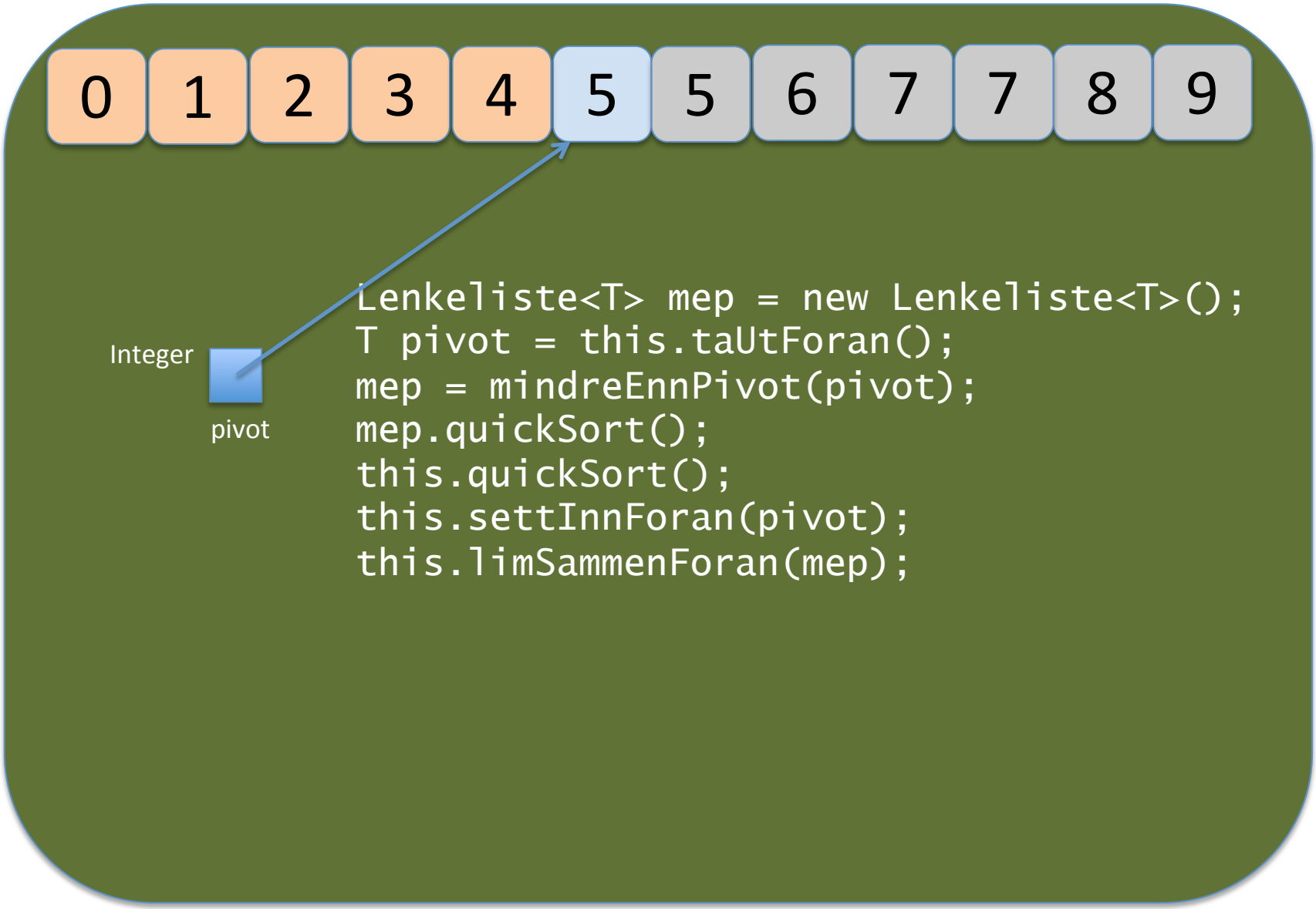
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Lenkeliste<T> mep = new Lenkeliste<T>();
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public void quickSort() {
    if (! tom() ) {
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        mep.quickSort();
        this.quickSort();
        this.settInnForan(pivot);
        this.limSammenForan(mep);
    }
}
```
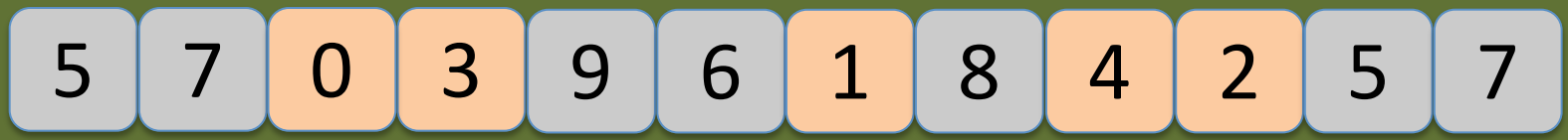
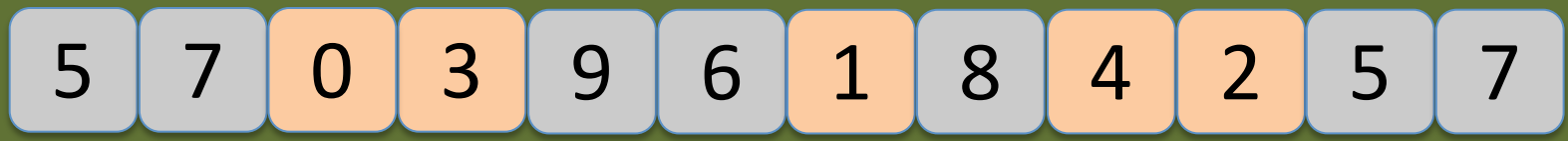




```
public void quickSort( ) {
    if ( ! tom( ) ) {
      T pivot = this.taUtForan( );
      Lenkeliste<T> mep = mindreEnnPivot(pivot);
      mep.quickSort( );
      this.quickSort( );
      this.settInnForan(pivot);
      limSammenForan(mep);
    }
}
```

Hvis lista er tom, returner uten å gjøre noe. Basistilfelle: ingen rekursive kall.

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      mep.quickSort( );
      this.quickSort( );
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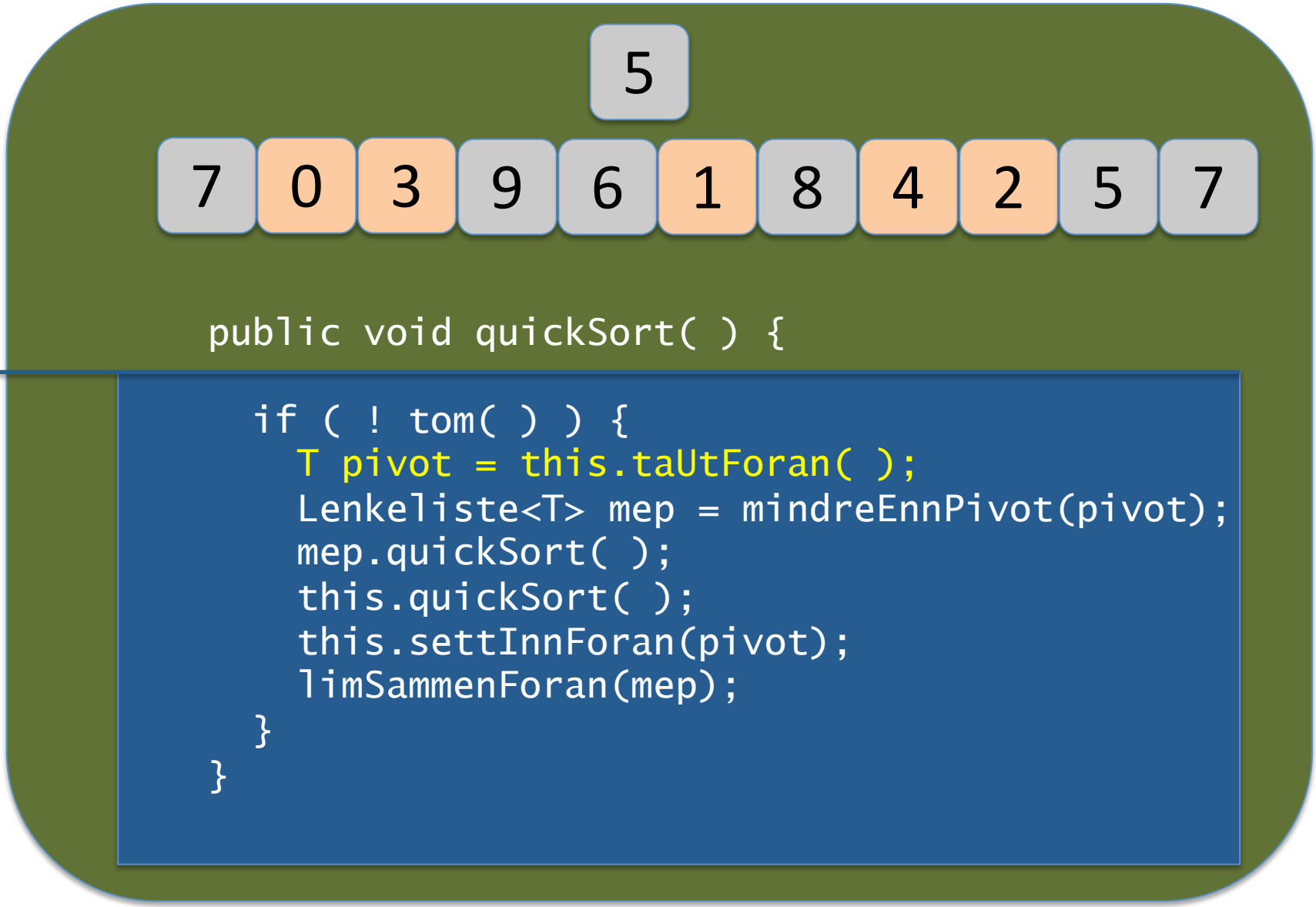
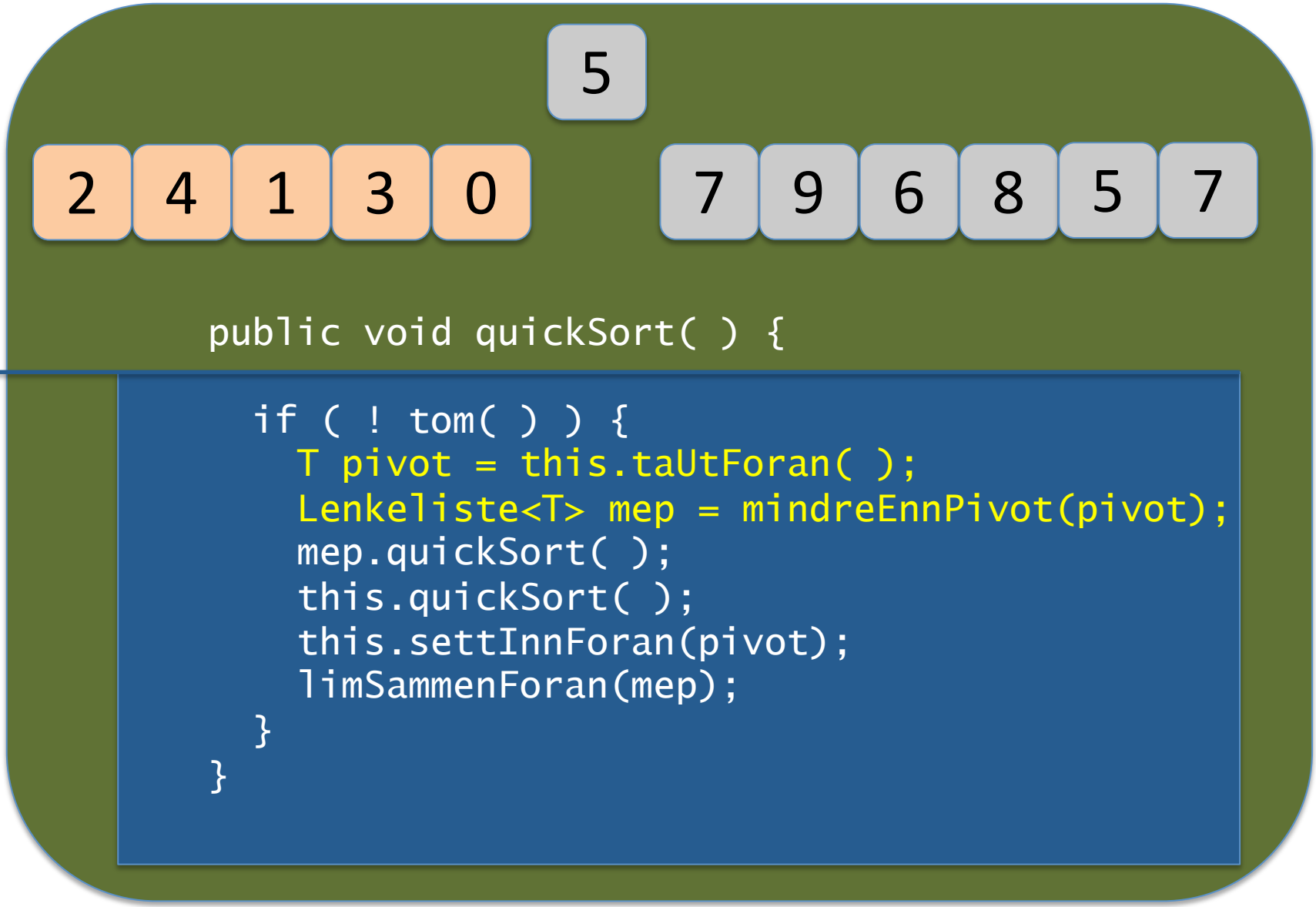
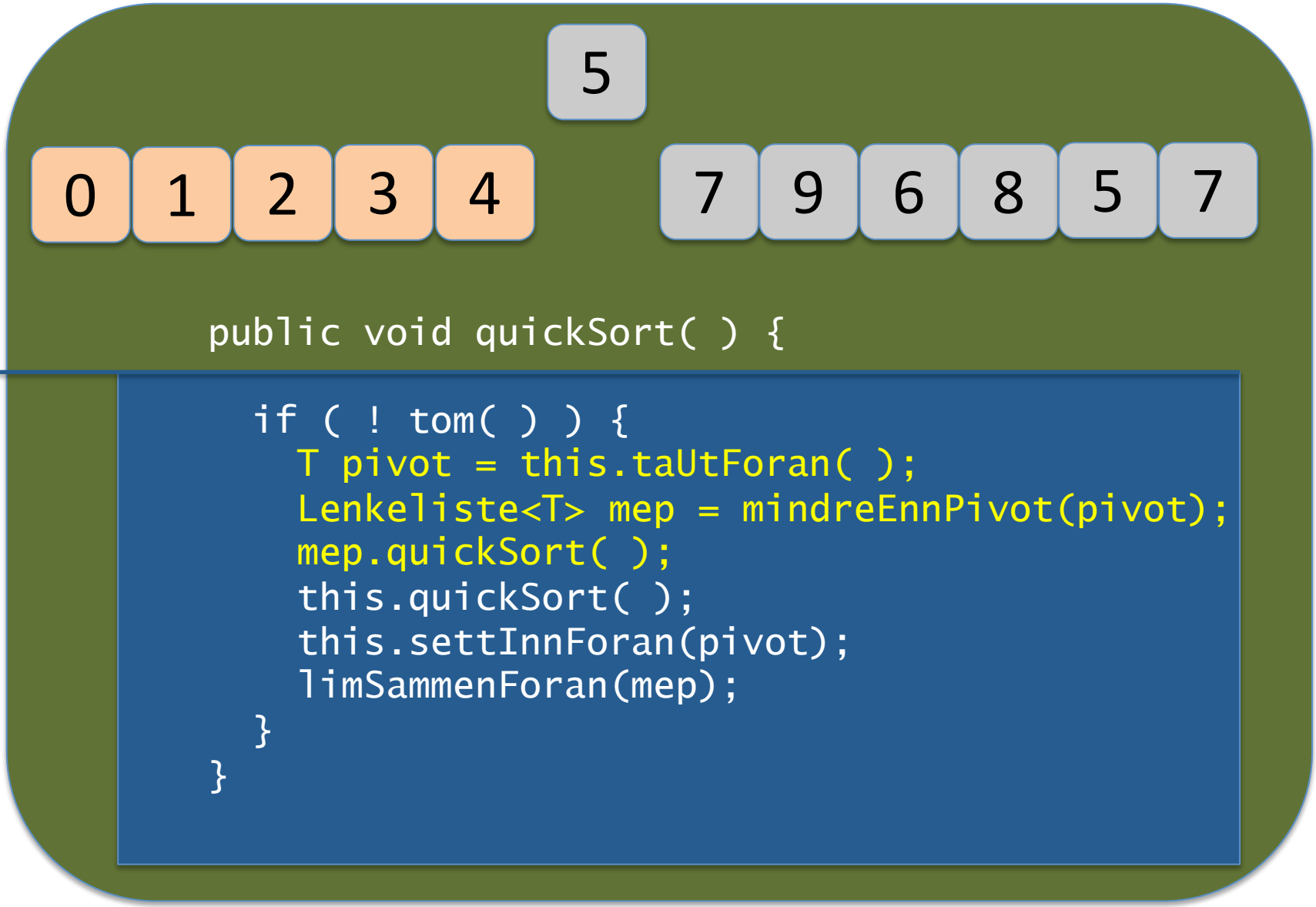
      limSammenForan(mep);
    }
}
```

Hvis lista ikke er tom, ta først ut objektet foran --- pivotobjektet

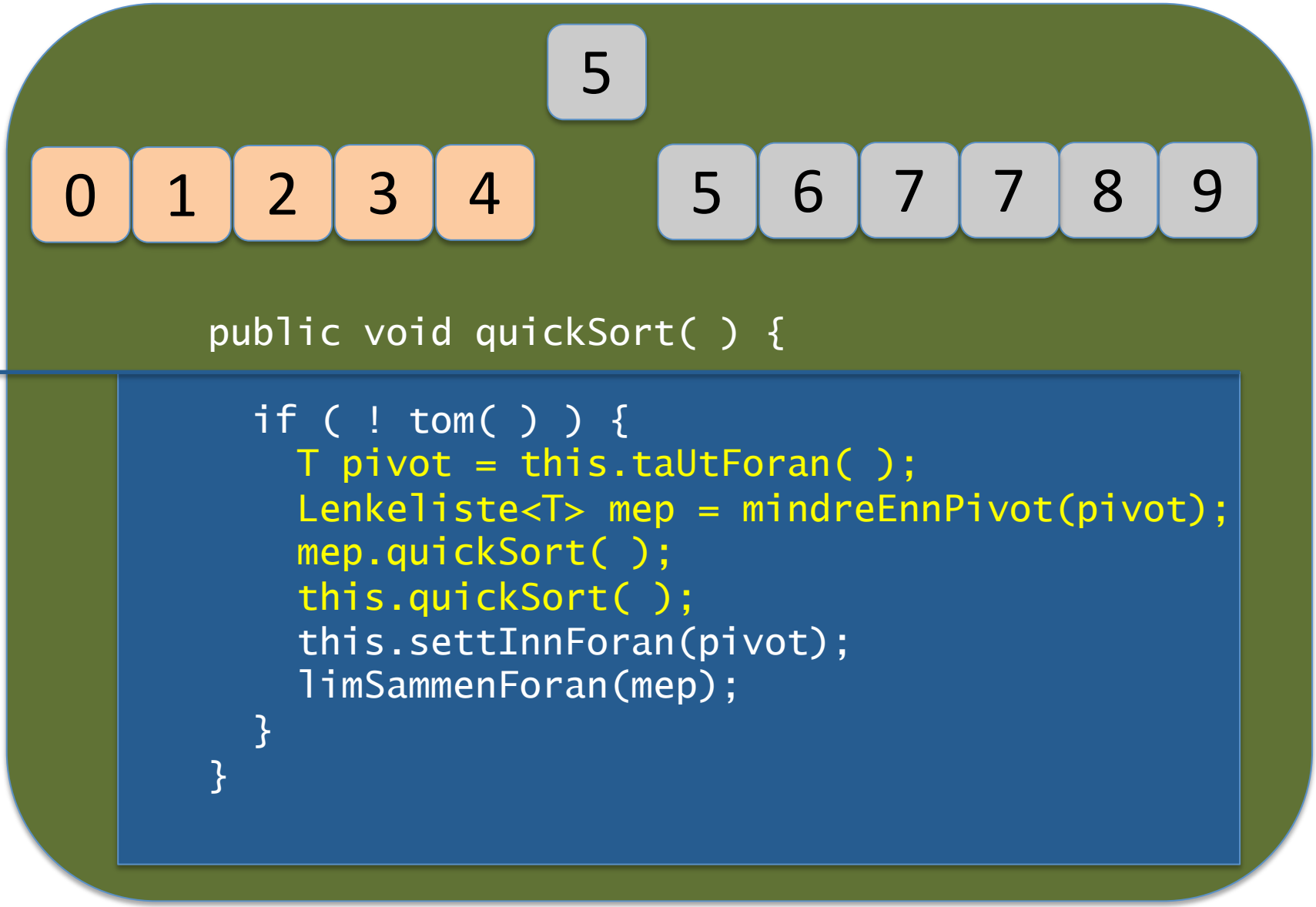

5
7 0 3 9 6 1 8 4 2 5 7
public void quickSort( ) {
if (! tom( )) {
T pivot = this.taUtForan( );
Lenkeliste<T> mep = mindreEnnPivot(pivot);
mep.quickSort( );
this.quickSort( );
this.settInnForan(pivot);
limSammenForan(mep);
}
}



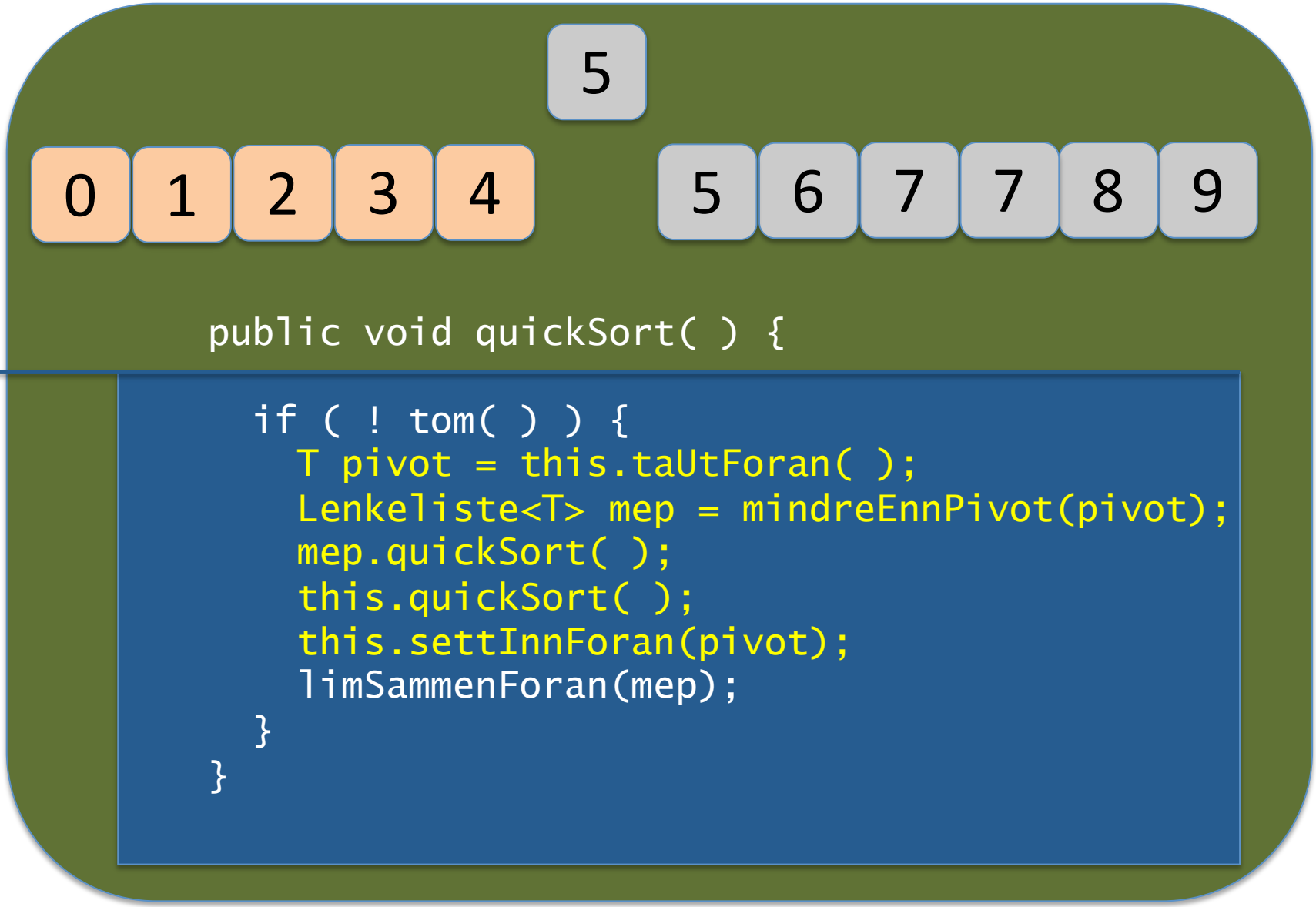
Skill ut objekter som er mindre enn pivot fra lista og legg dem inn i ei ny lenkeliste (mep)



Sorter lista med små elementer (mep) vha. quicksort (rekursivt kall)



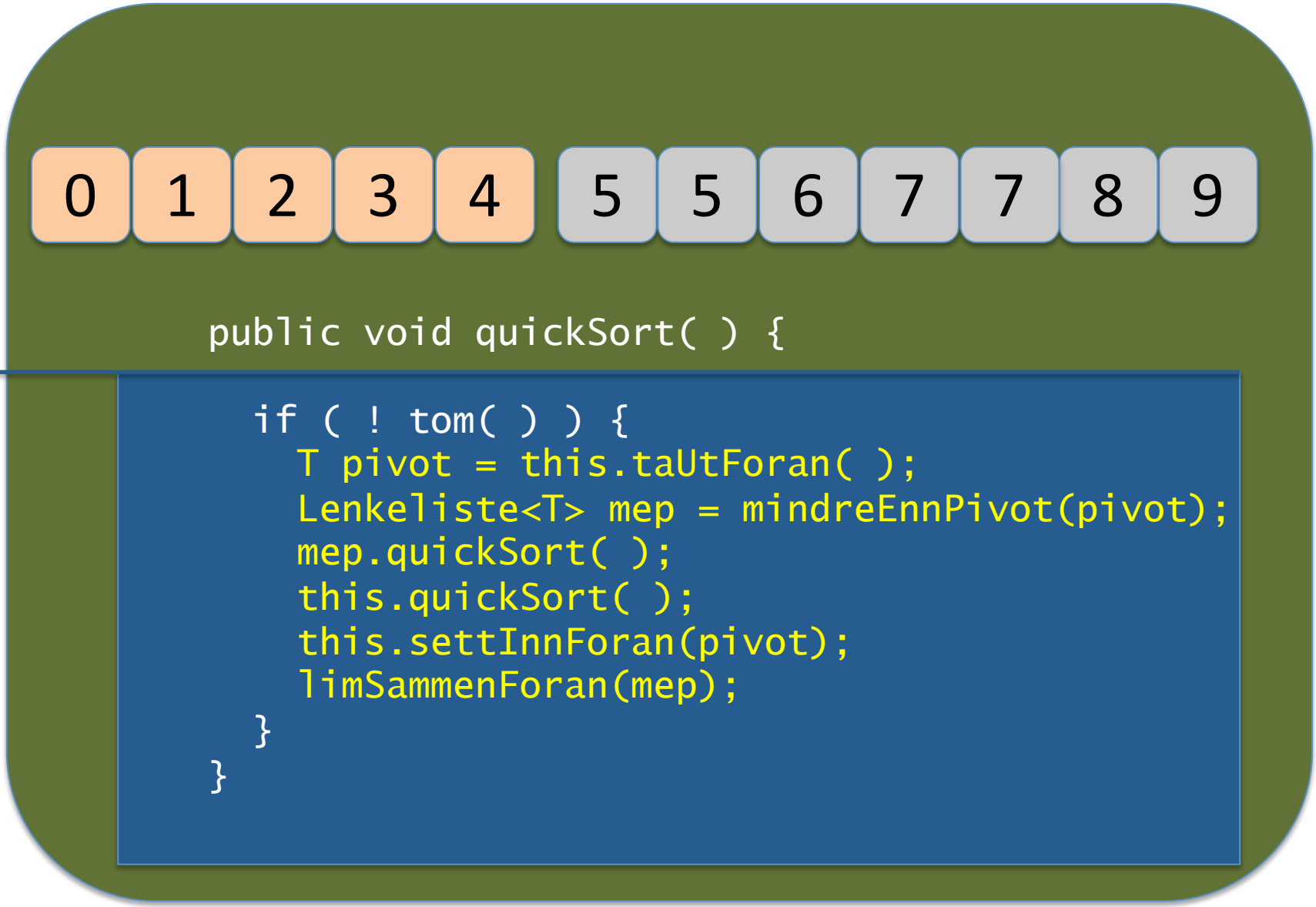
Sorter restlista med store elementer (this) vha. quicksort (rekursivt kall)



Sett pivotobjektet foran lista med de store verdiene

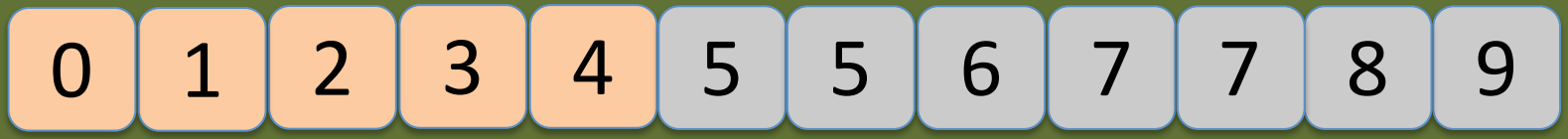

```
public void quickSort( ) {

    if ( ! tom( ) ) {
      T pivot = this.taUtForan( );
      Lenkeliste<T> mep = mindreEnnPivot(pivot);
      mep.quickSort( );
      this.quickSort( );
      this.settInnForan(pivot);
      limSammenForan(mep);
    }
}
```

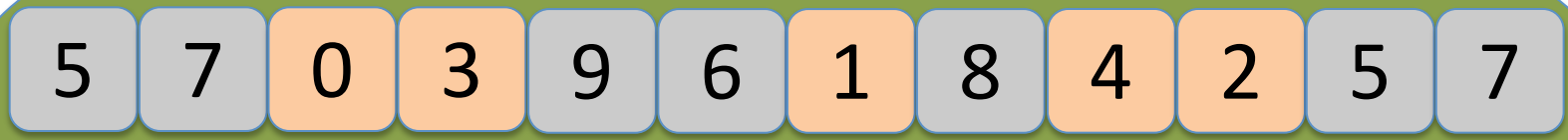


Skjøt de to listene sammen, den med små verdier foran de store …

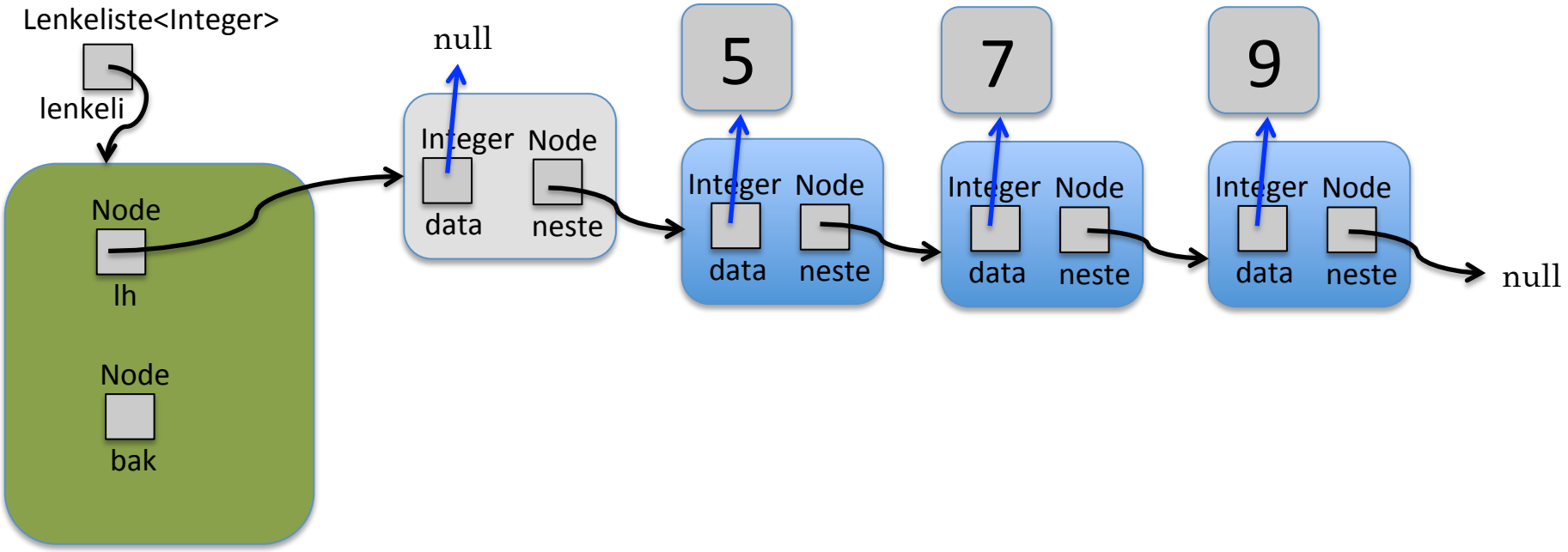

```
public void quickSort( ) {
    if ( ! tom( ) ) {
      T pivot = this.taUtForan( );
      Lenkeliste<T> mep = mindreEnnPivot(pivot);
      mep.quickSort( );
      this.quickSort( );
      this.settInnForan(pivot);
      limSammenForan(mep);
    }
}
```



…et voilà !




```
private Lenkeliste<T> mindreEnnPivot(T pivot) {
    Lenkeliste<T> mep = new Lenkeliste<T>();
    Iterator<T> it = iterator();
    while (it.hasNext()) {
        T t = it.next();
        if ( t.compareTo(pivot) <= 0 ) {
           mep.settInnForan(t);
           it.remove();
        }
    }
    return mep;
}
```


Lenkeliste<Integer>
lenkeli
Node
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Node
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Integer
Node
data
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7
9
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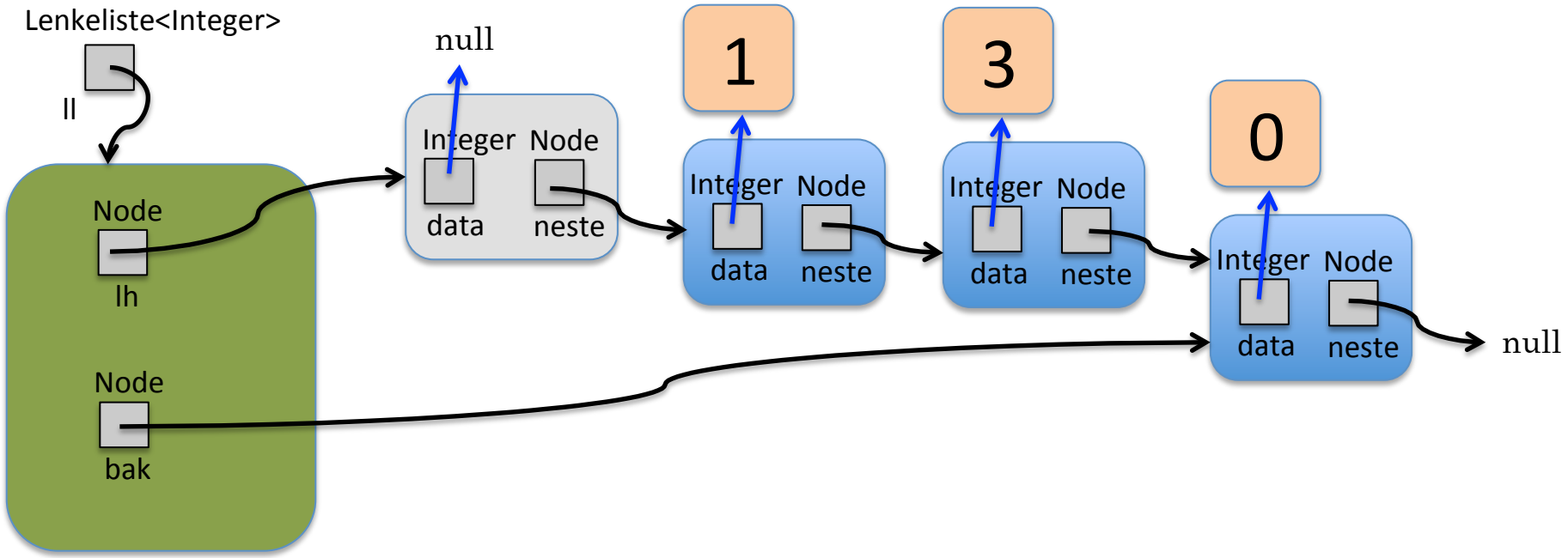
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Node
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Node
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Integer
Node
data
neste
1
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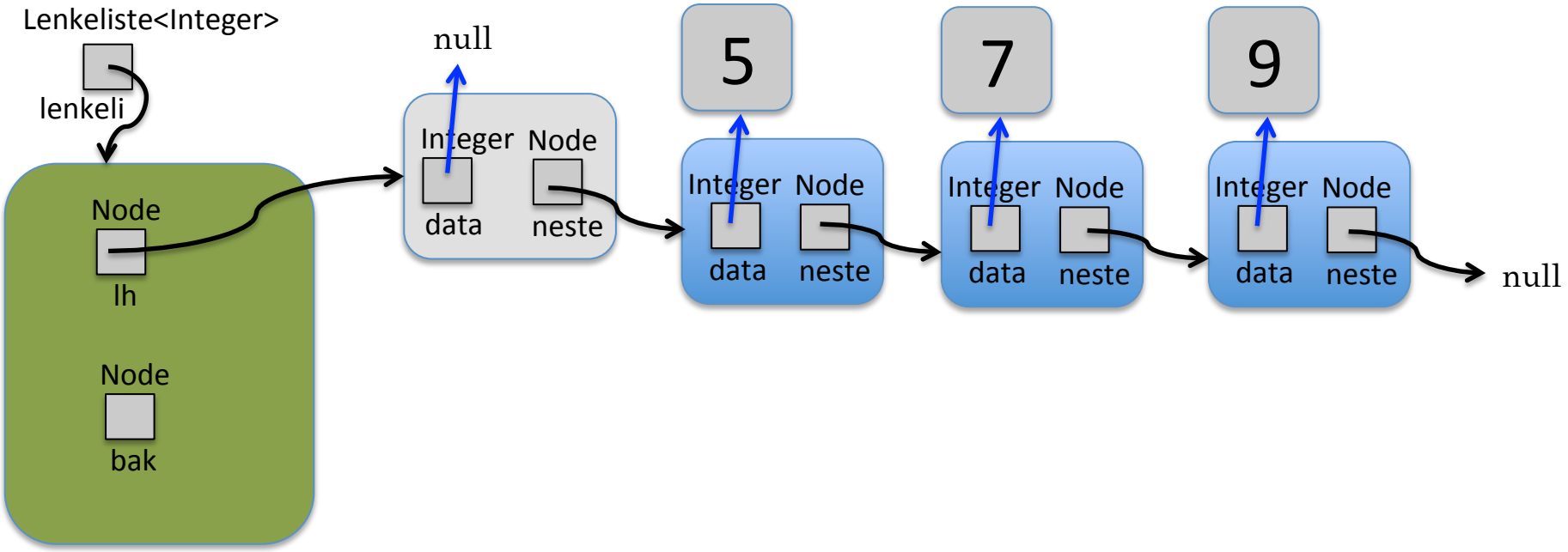
null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Node
lh
Node
bak
null
Integer
Node
data
neste
5
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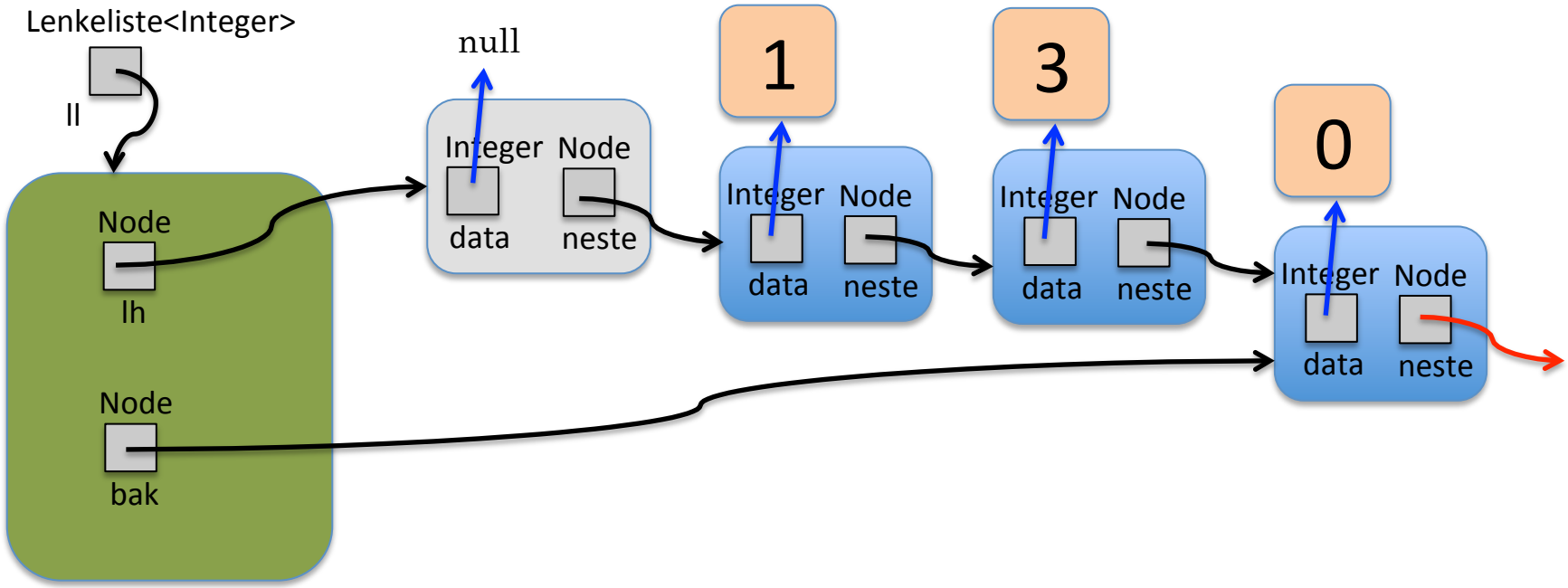
9
null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Node
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Node
bak
null
Integer
Node
data
neste
1
3
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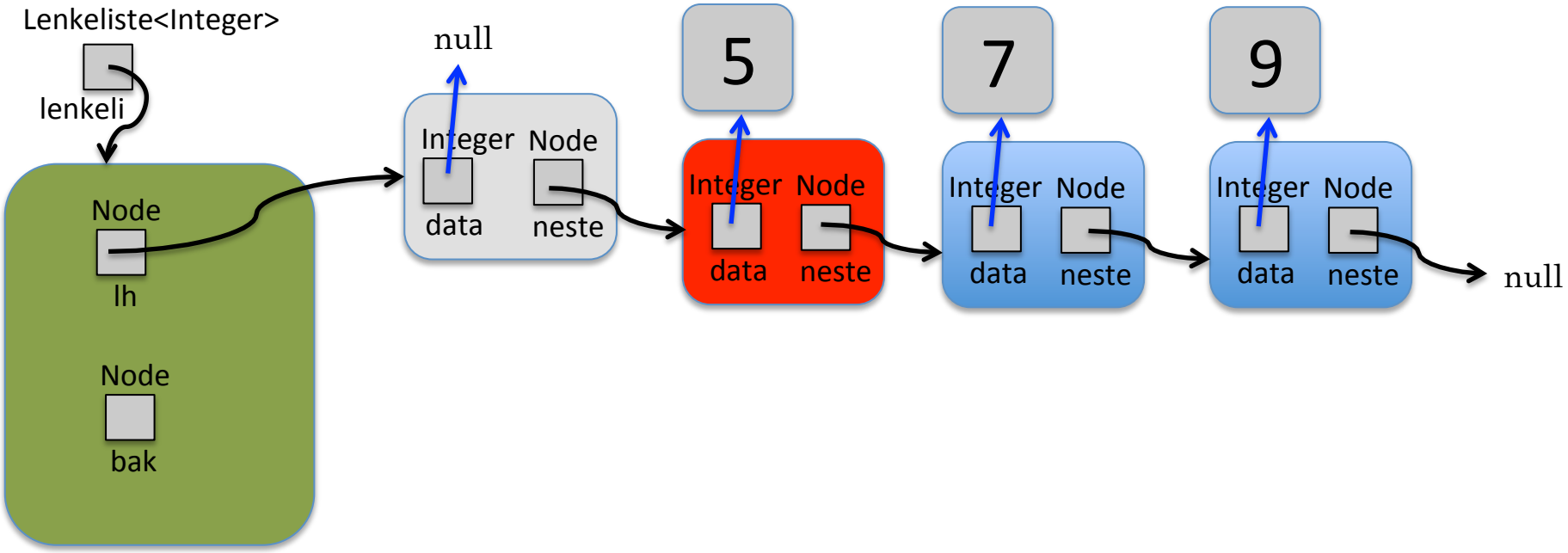
Lenkeliste<Integer>
lenkeli
Node
lh
Node
bak
null
Integer
Node
data
neste
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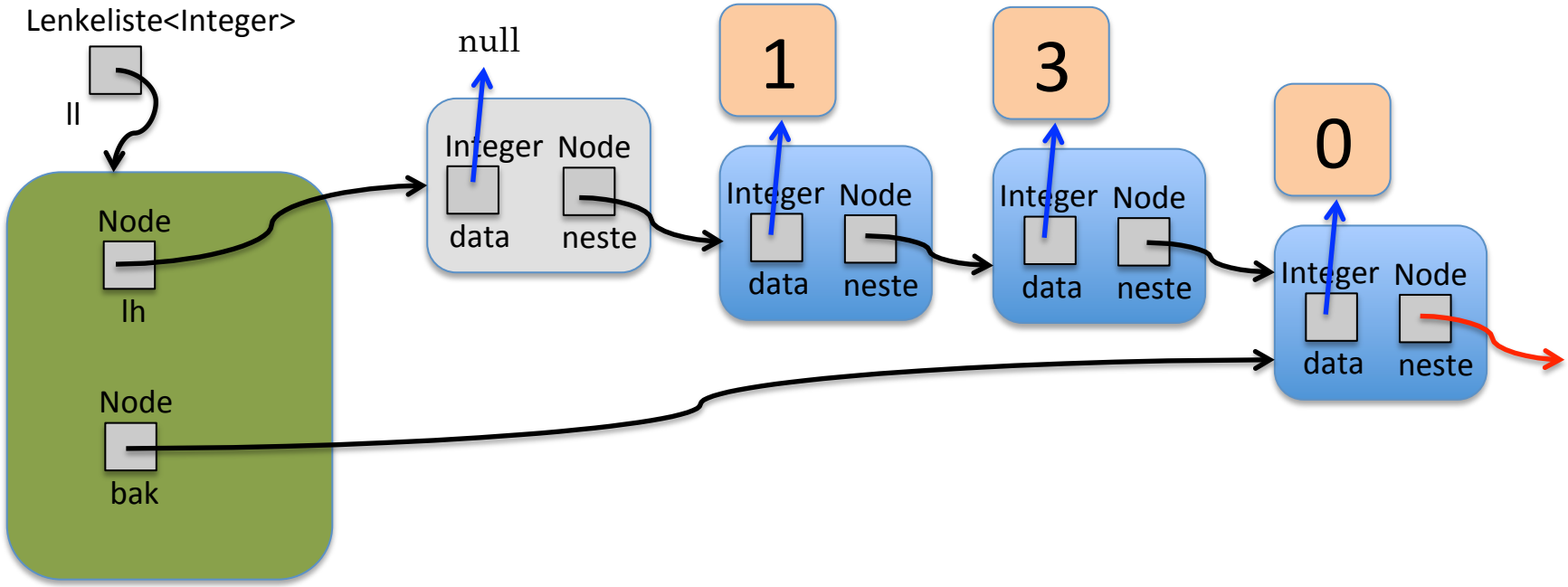
9
null


Lenkeliste<Integer>
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lh
Node
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neste
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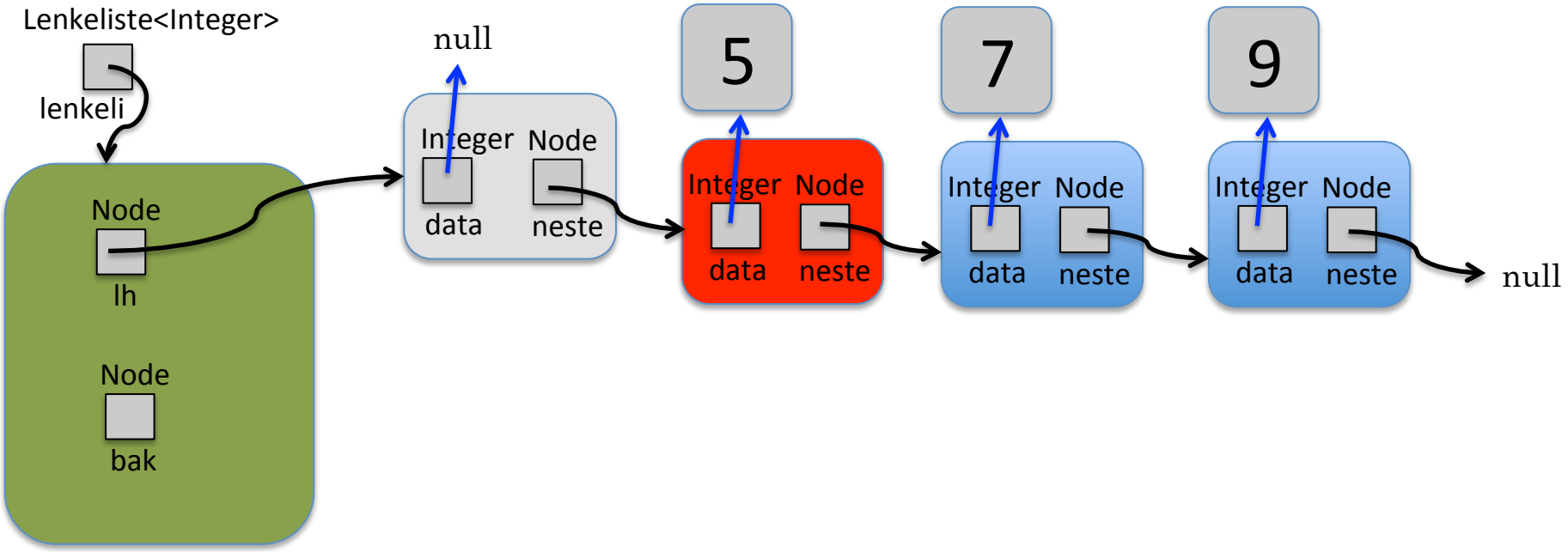
Lenkeliste<Integer>
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Node
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Node
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Integer
Node
data
neste
5
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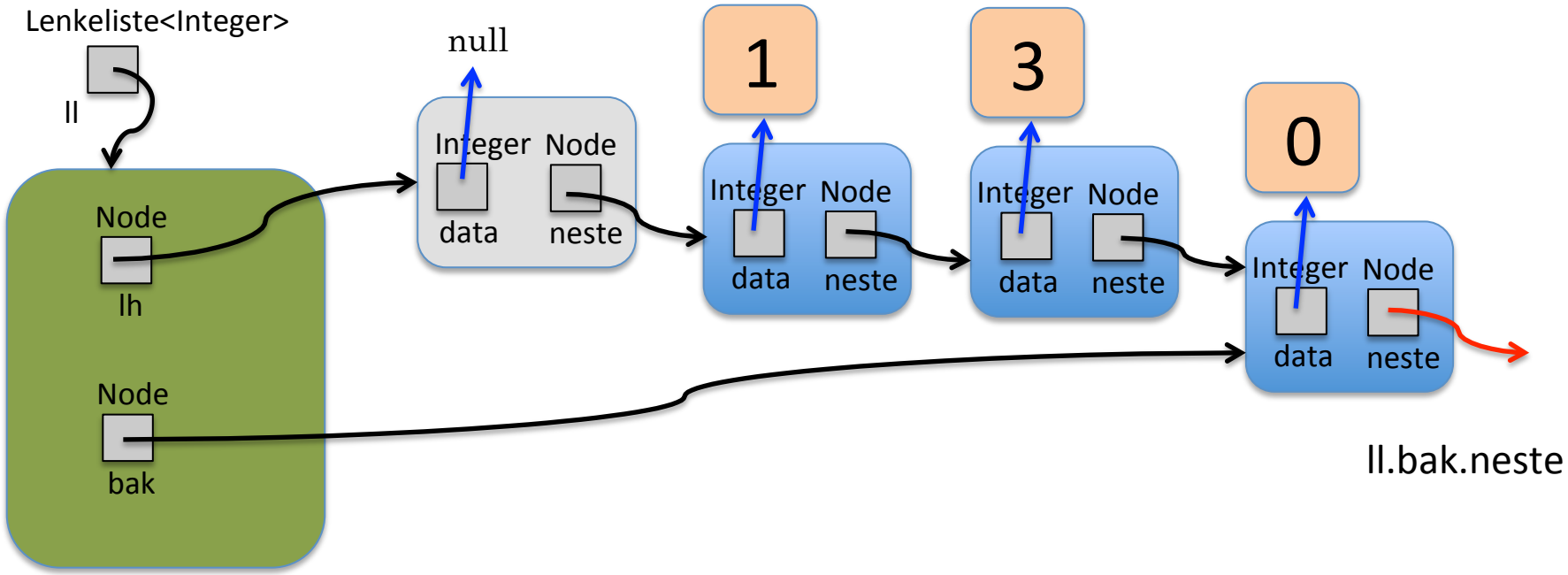
null


Lenkeliste<Integer>
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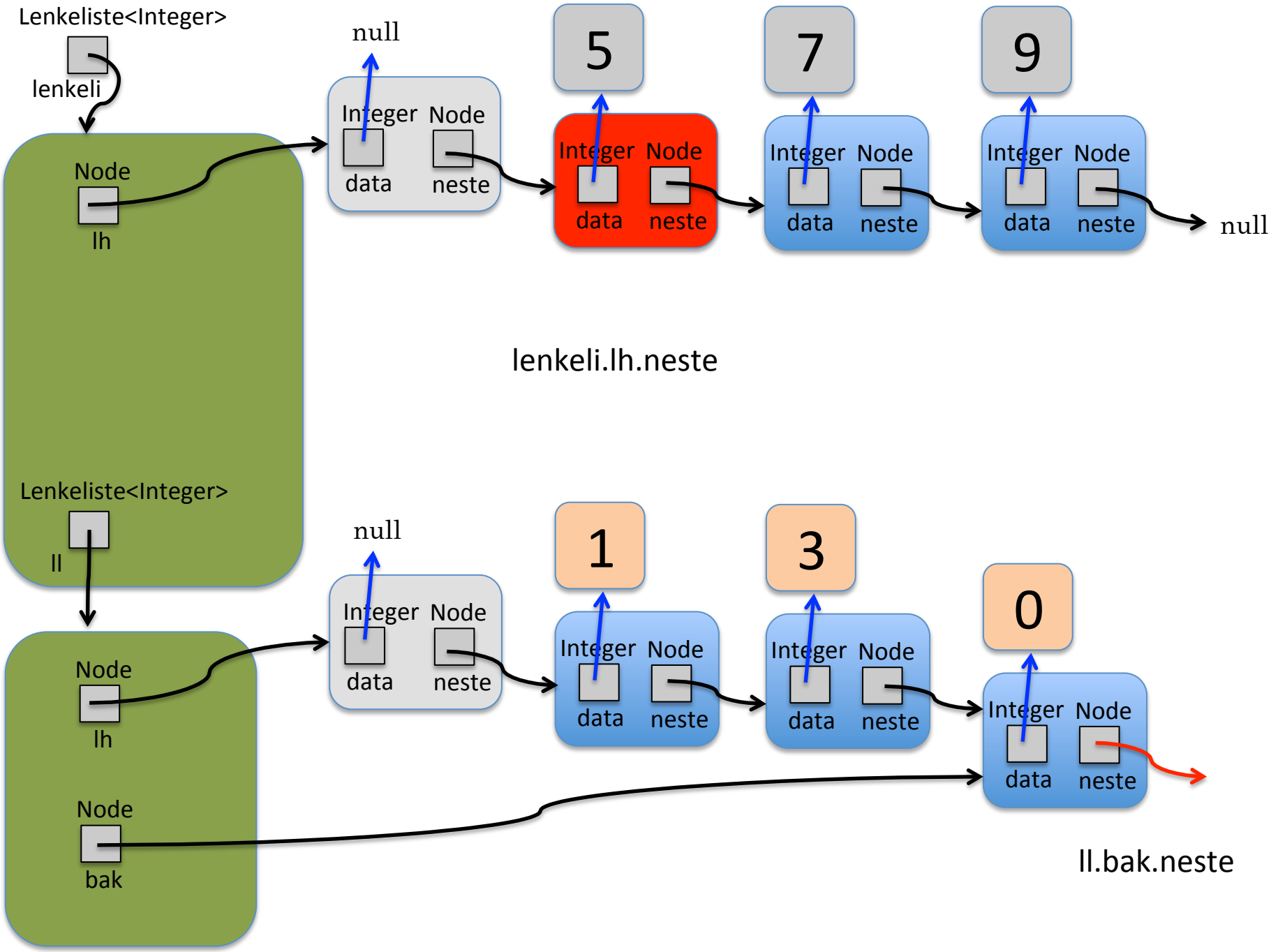
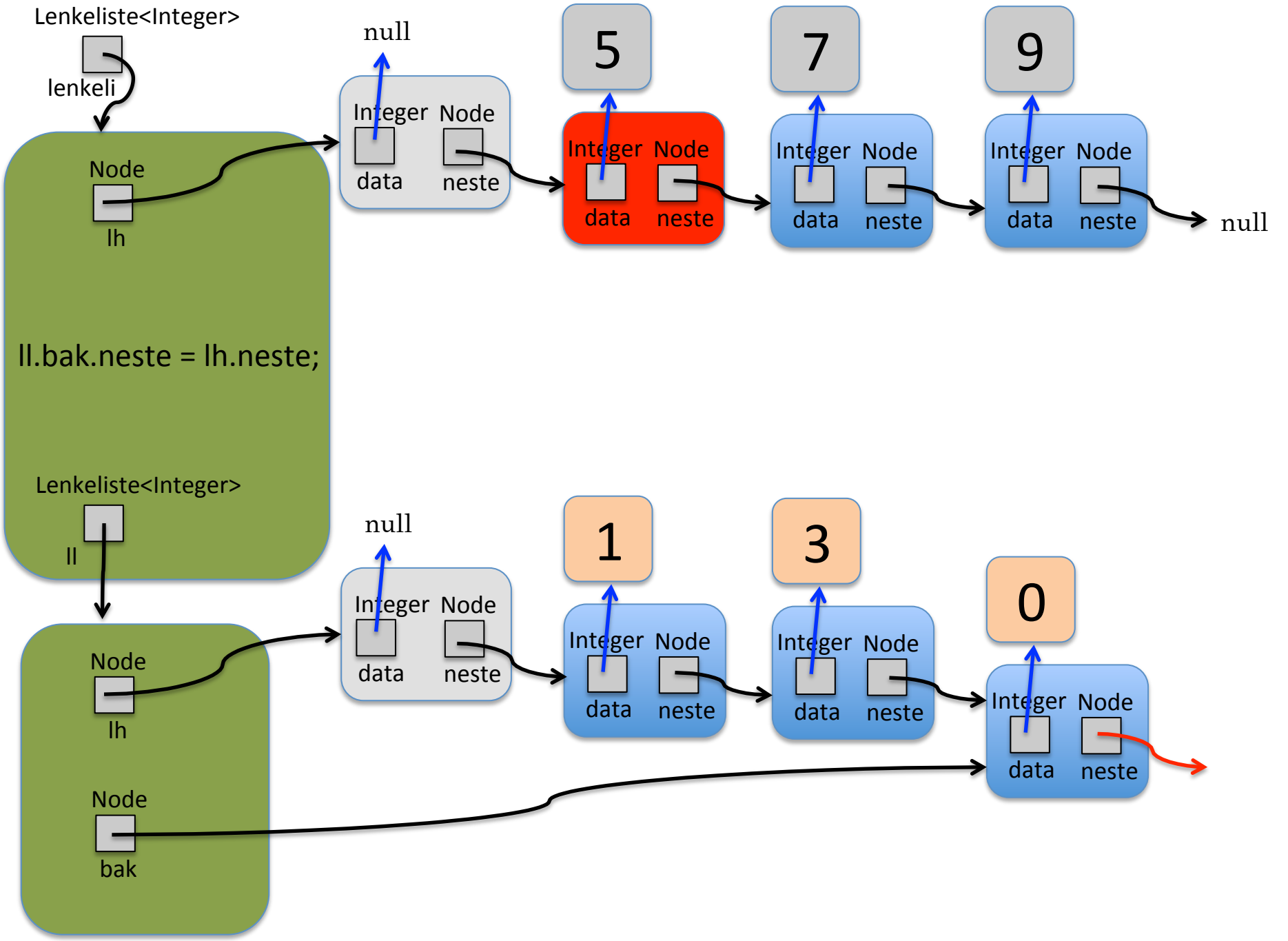
Node
lh
Node
bak
null
Integer
Node
data
neste
1
3
0
ll.bak.neste


Lenkeliste<Integer>
lenkeli
Node
lh
null
Integer
Node
data
neste
5
7
9
null
lenkeli.lh.neste
Lenkeliste<Integer>
ll
Node
lh
Node
bak
1
3
0
ll.bak.neste


Lenkeliste<Integer>
lenkeli
Node
lh
ll.bak.neste = lh.neste;
Lenkeliste<Integer>
ll
Node
lh
Node
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null
Integer Node
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7
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null
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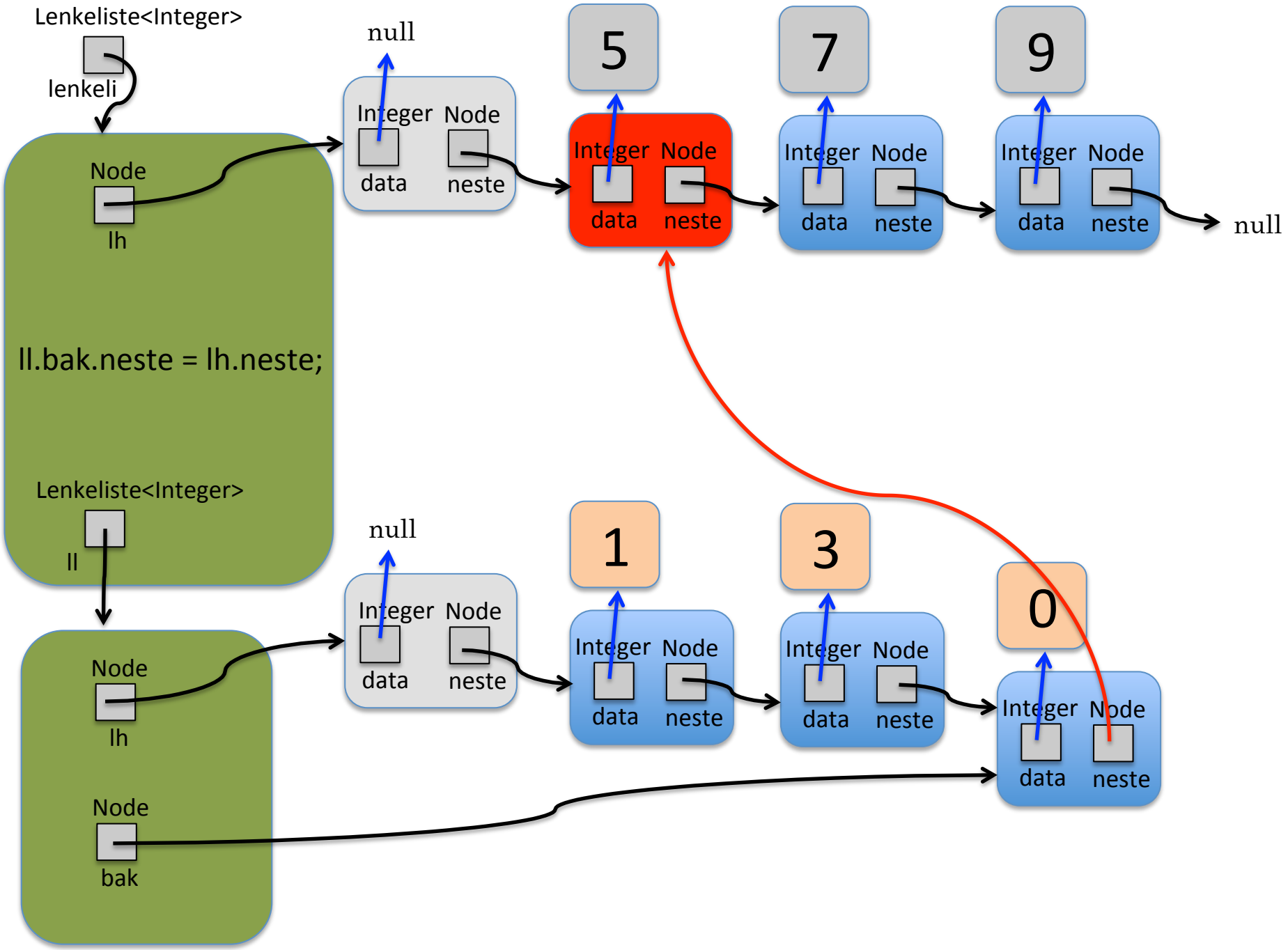
Lenkeliste<Integer>
lenkeli
Node
lh
ll.bak.neste = lh.neste;
Lenkeliste<Integer>
ll
Node
lh
Node
bak
null
Integer Node
data neste
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9
null
1
3
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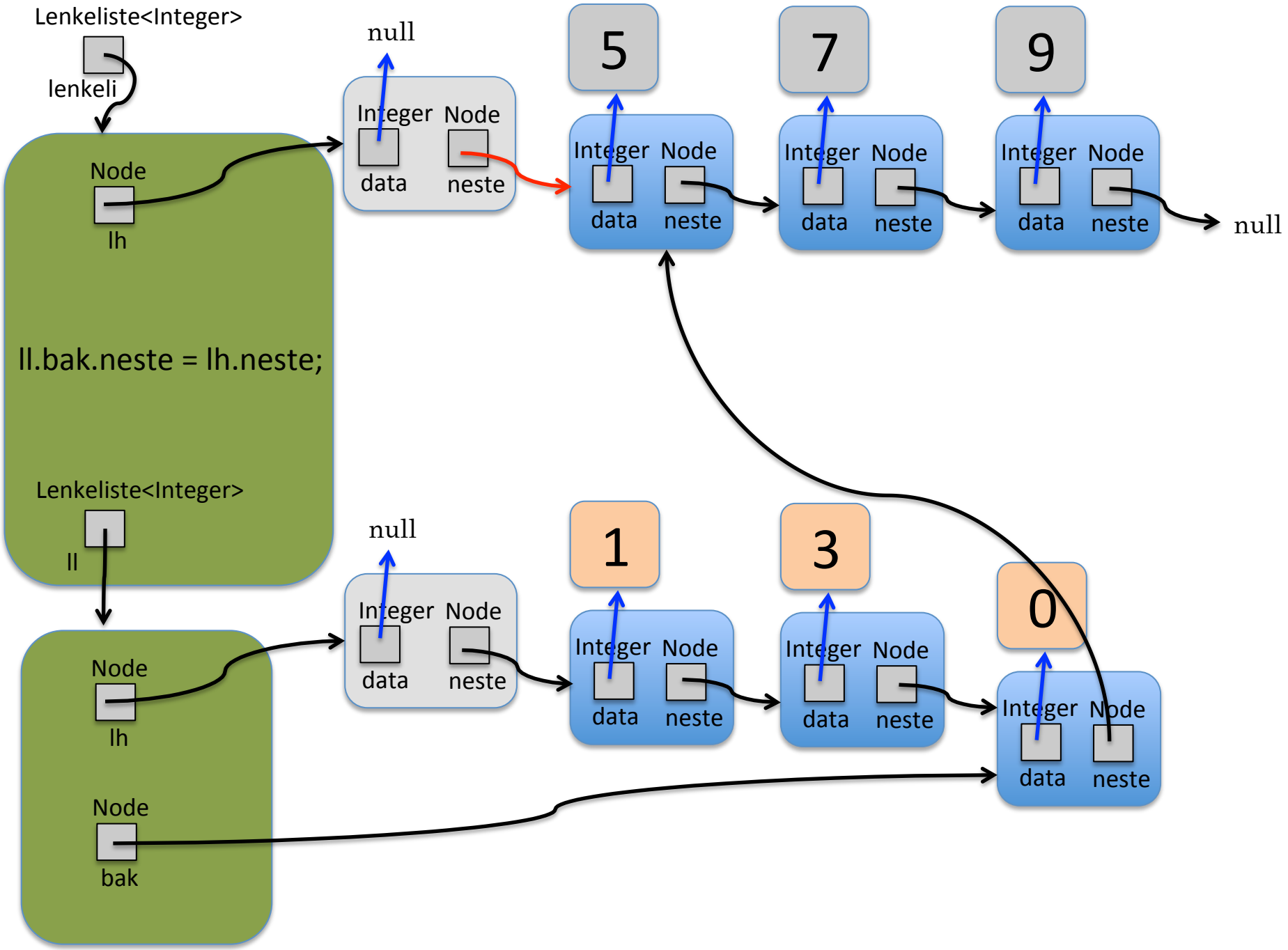
Lenkeliste<Integer>
lenkeli
Node
lh
ll.bak.neste = lh.neste;
Lenkeliste<Integer>
ll
Node
lh
Node
bak
null
Integer Node
data neste
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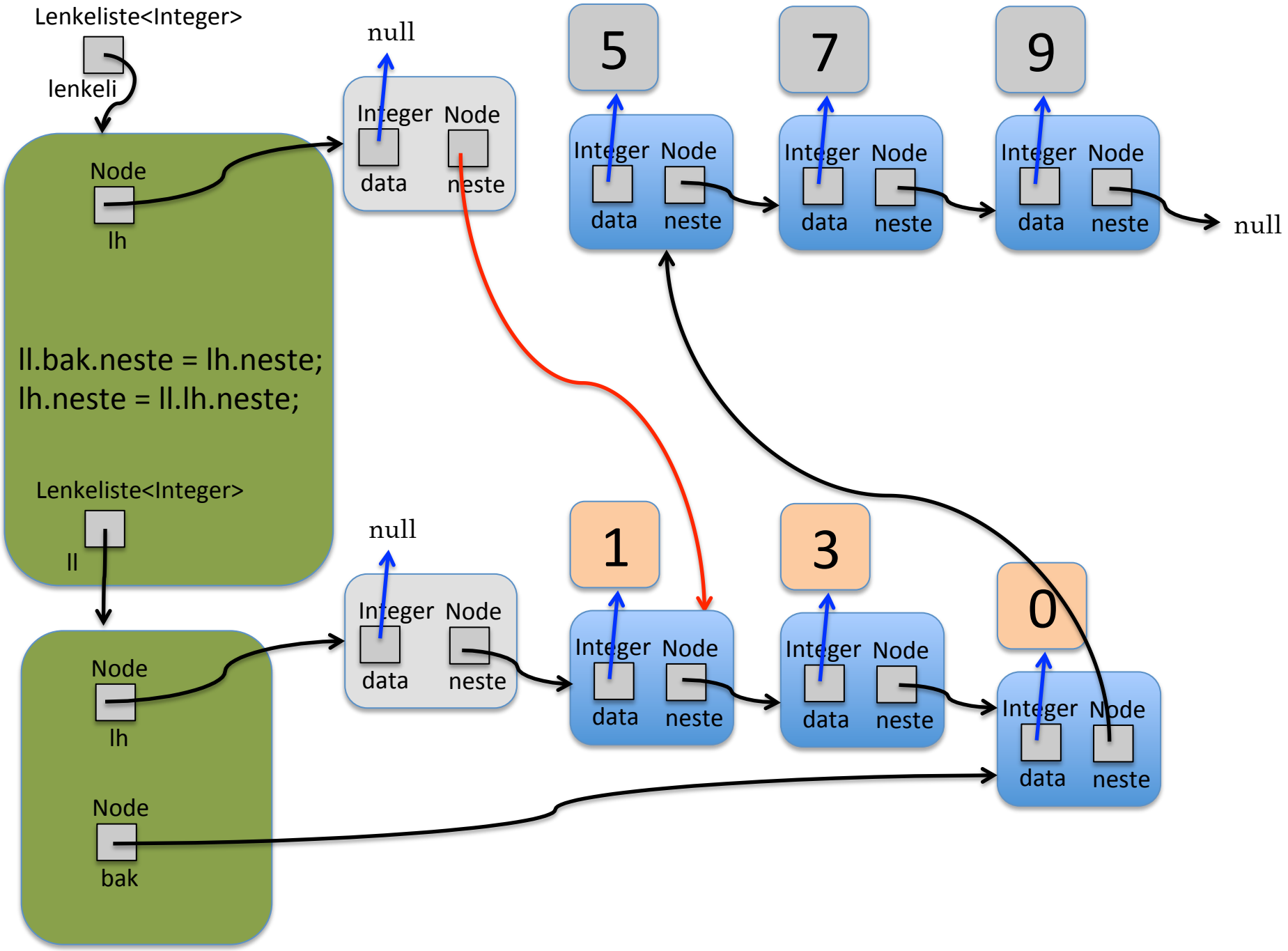
7
9
null
1
3
0


Lenkeliste<Integer>
lenkeli
Node
lh
ll.bak.neste = lh.neste;
lh.neste = ll.lh.neste;
Lenkeliste<Integer>
ll
Node
lh
Node
bak
null
Integer Node
data neste
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7
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null
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3
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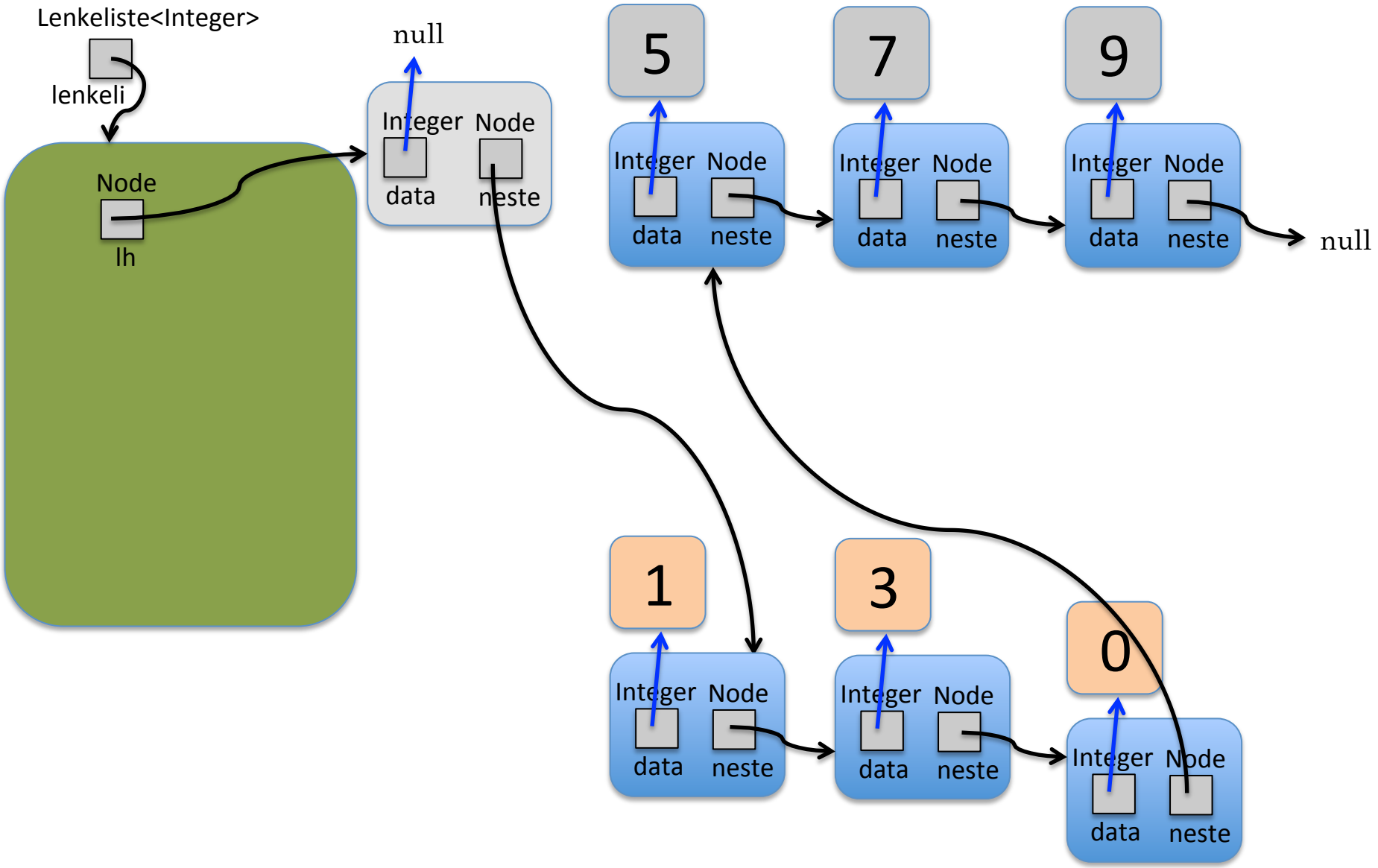
Lenkeliste<Integer>
lenkeli
Node
lh
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Node
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5
7
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3
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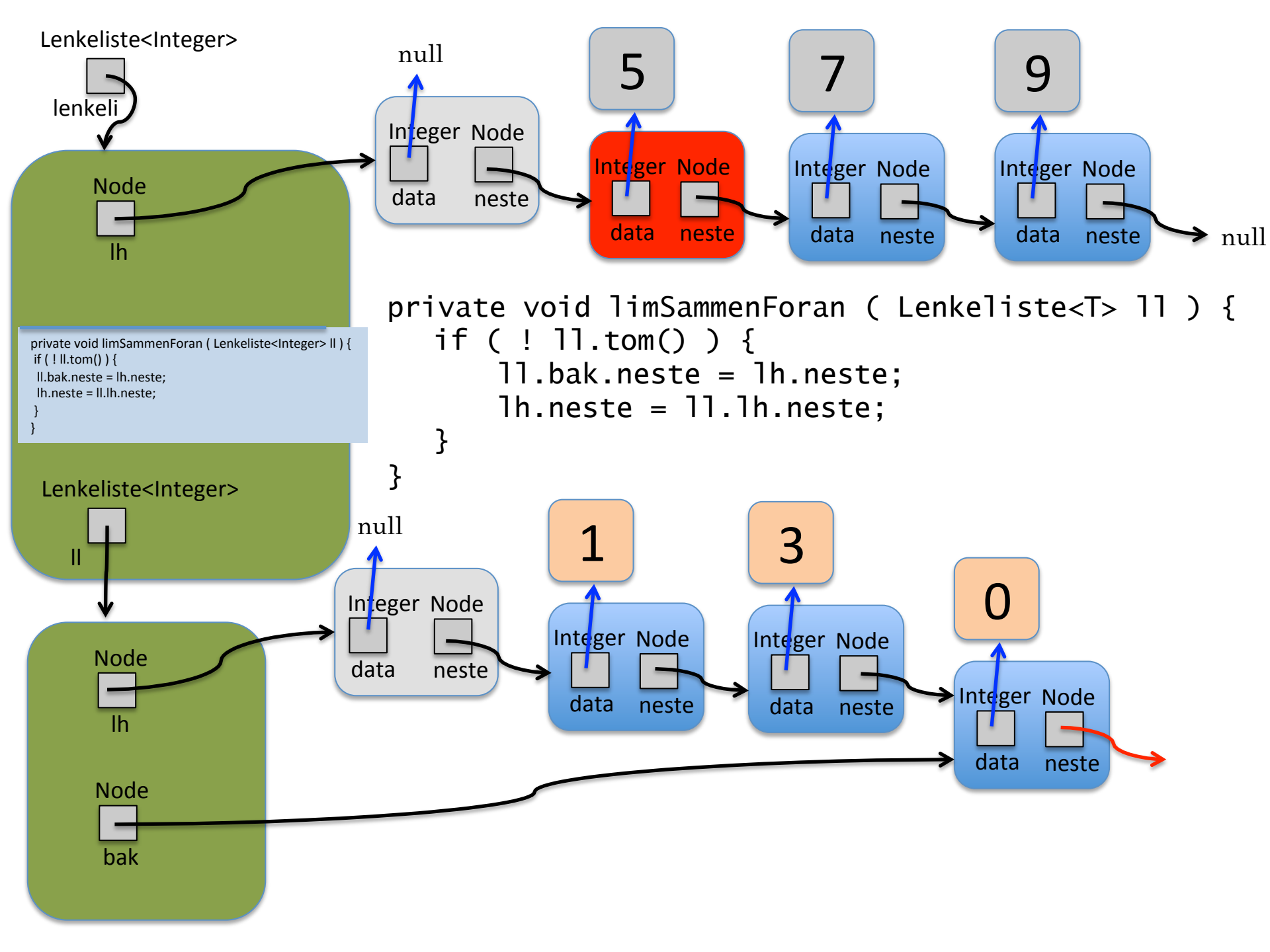
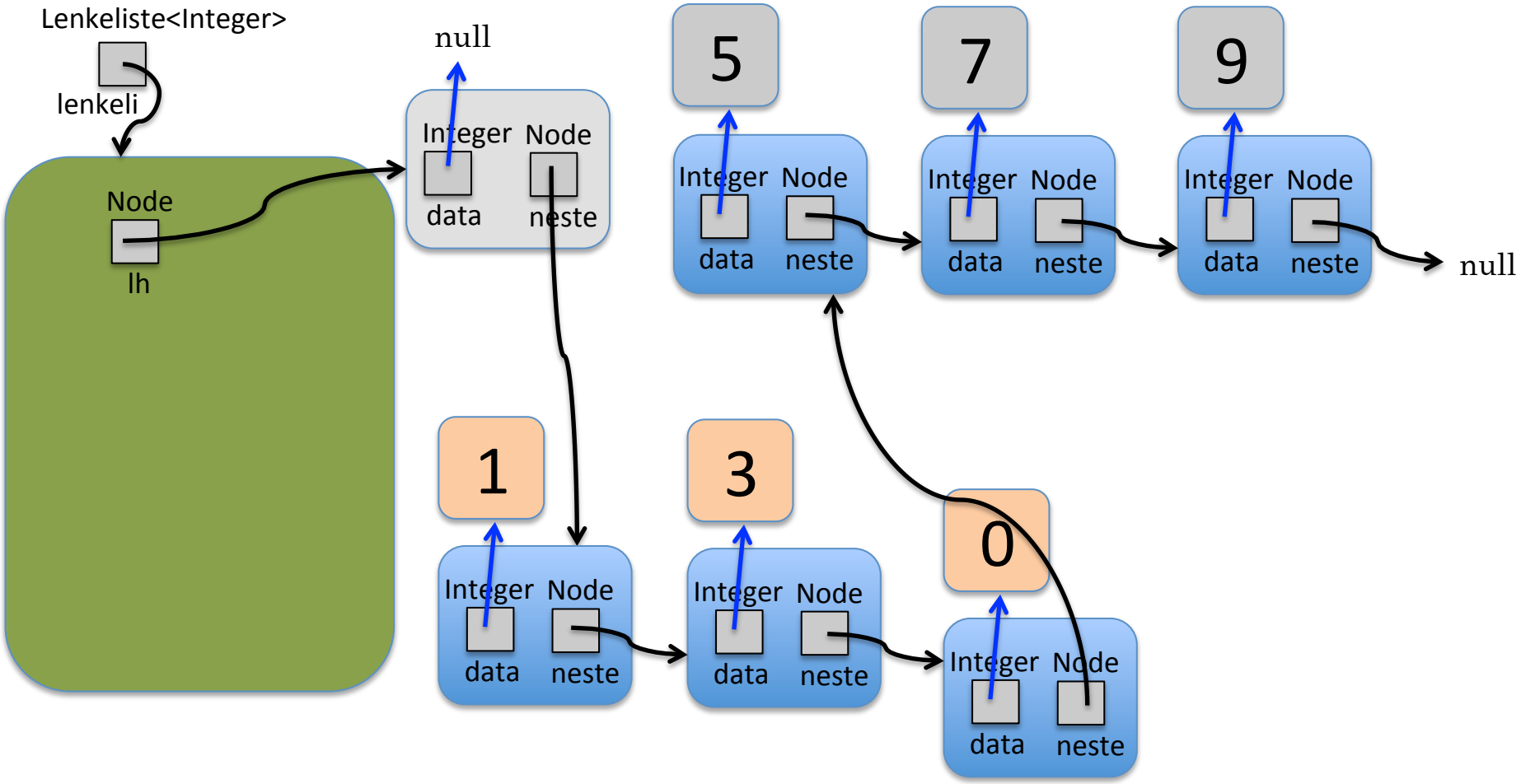
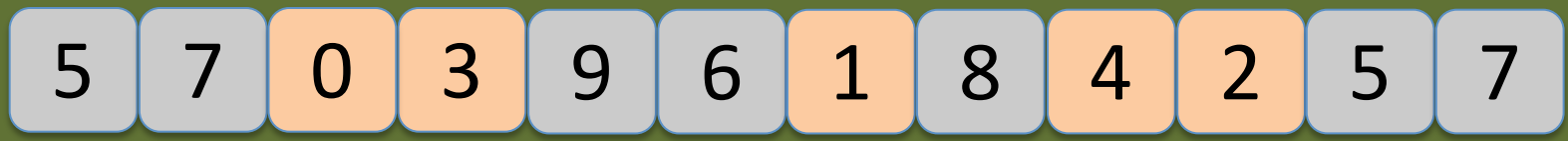

Lenkeliste<Integer>
lenkeli
Node
lh
null
Integer Node
data neste
5
7
9
null
private void limSammenForan (Lenkeliste<Integer> ll) {
if (! ll.tom()) {
ll.bak.neste = lh.neste;
lh.neste = ll.lh.neste;
}
}
Lenkeliste<Integer>
ll
Node
lh
Node
bak
1
3
0
private void limSammenForan (Lenkeliste<T> ll) {
if (! ll.tom()) {
ll.bak.neste = lh.neste;
lh.neste = ll.lh.neste;
}
}




```
private void limSammenForan ( Lenkeliste<T> ll ) {
   if ( ! ll.tom() ) {
       ll.bak.neste = lh.neste;
       lh.neste = ll.lh.neste;
   }
}
```

```
public void quickSort() {
    if (! tom() ) {
        Lenkeliste<T> mep = new Lenkeliste<T>();
        T pivot = this.taUtForan();
        mep = mindreEnnPivot(pivot);
        mep.quickSort(); this.quickSort();
        this.settInnForan(pivot);
        limSammenForan(mep);
    }
}
```

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    if (! tom() ) {
        Lenkeliste<T> mep = new Lenkeliste<T>();
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        mep.quickSort(); this.quickSort();
        this.settInnForan(pivot);
        limSammenForan(mep);
    }
}
```

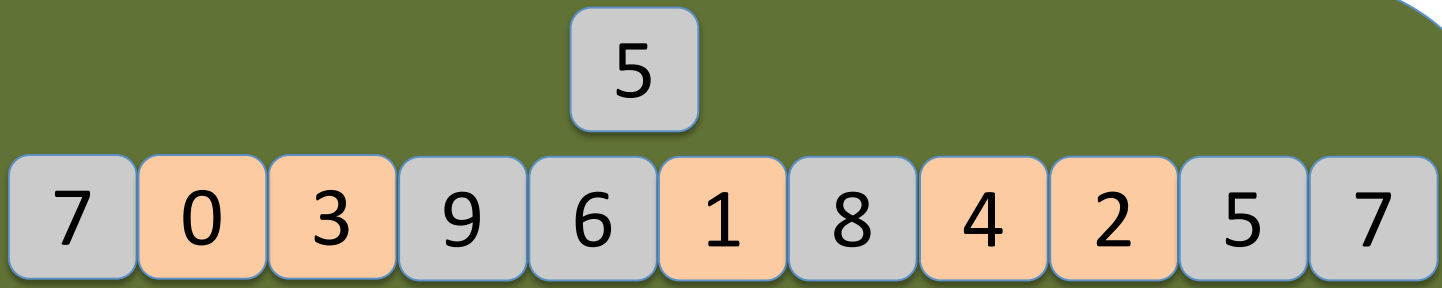


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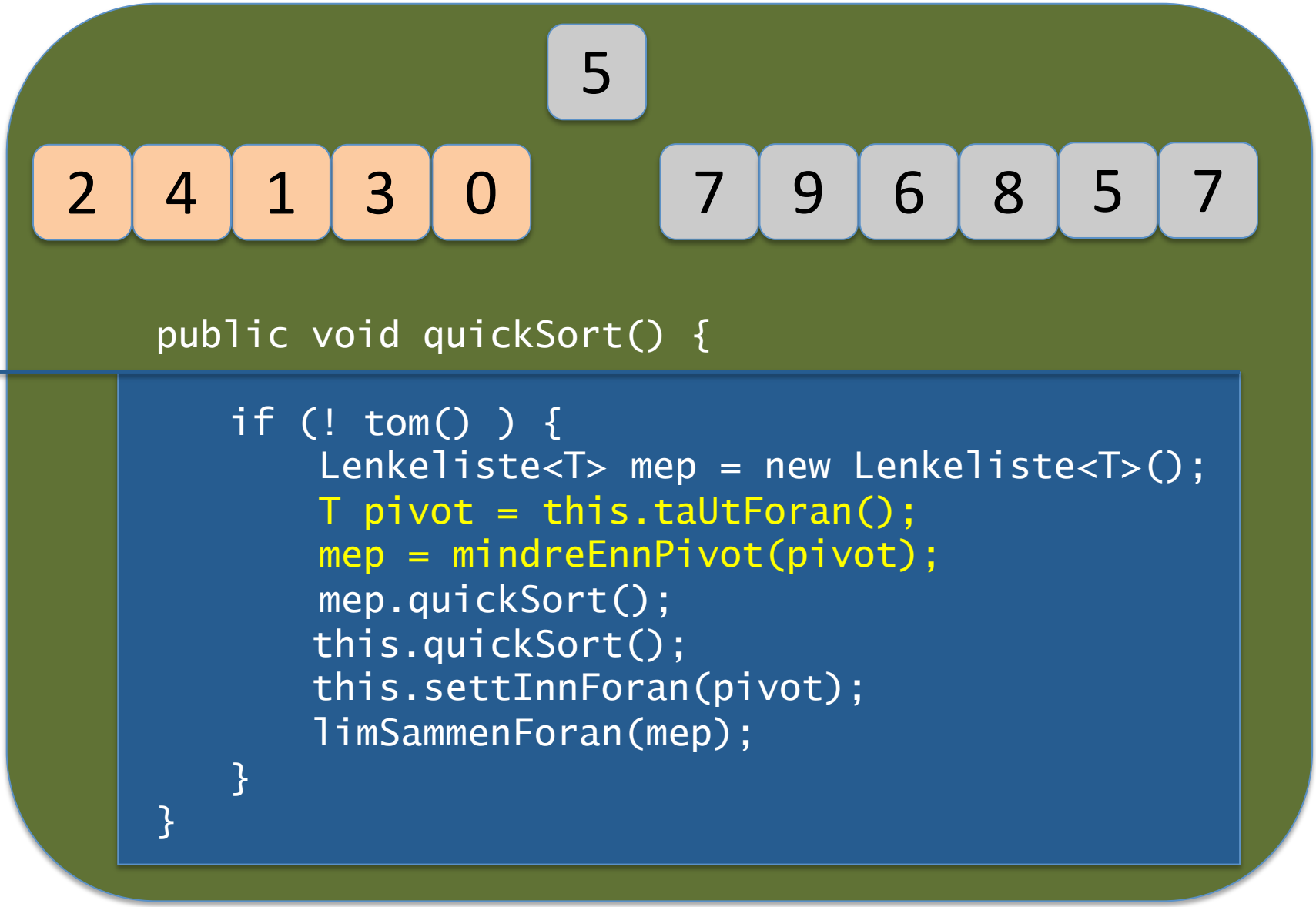
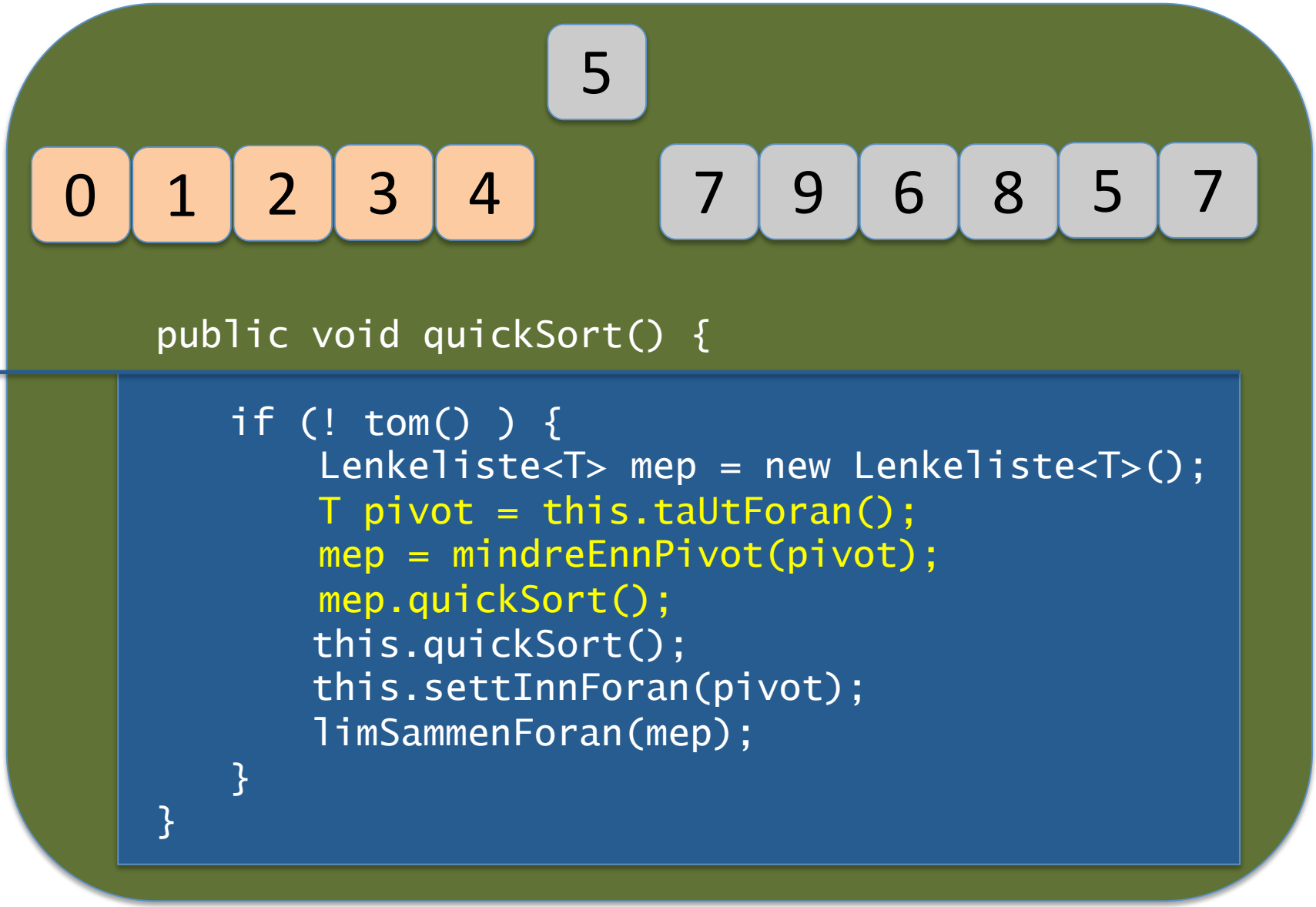
    }
}
```


5
2 4 1 3 0
7 9 6 8 5 7
public void quickSort() {
if (! tom()) {
Lenkeliste<T> mep = new Lenkeliste<T>();
T pivot = this.taUtForan();
mep = mindreEnnPivot(pivot);
mep.quickSort();
this.quickSort();
this.settInnForan(pivot);
limSammenForan(mep);
}
}


5
0 1 2 3 4
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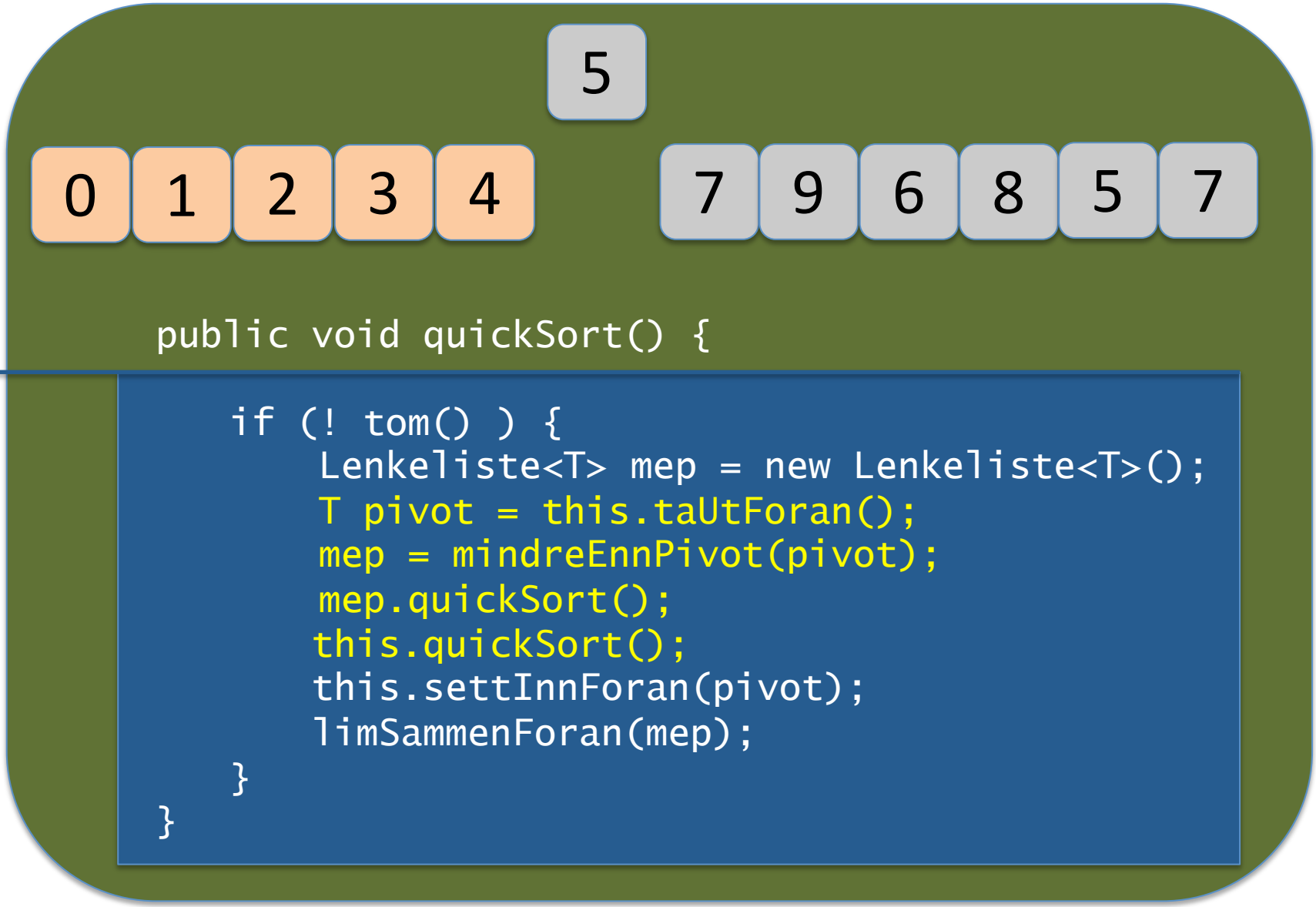
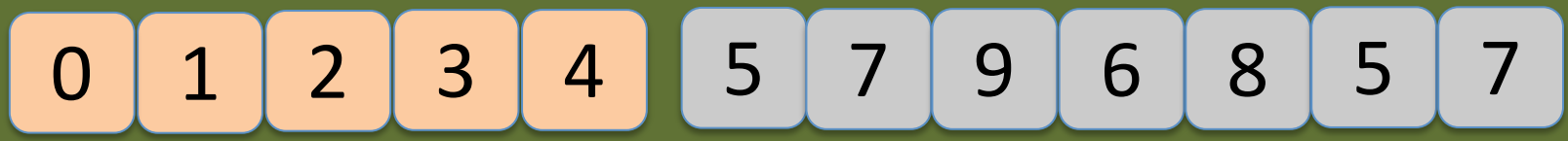
mep = mindreEnnPivot(pivot);
mep.quickSort();
this.quickSort();
this.settInnForan(pivot);
limSammenForan(mep);
}
}


5
0 1 2 3 4
7 9 6 8 5 7
public void quickSort() {
if (! tom()) {
Lenkeliste<T> mep = new Lenkeliste<T>();
T pivot = this.taUtForan();
mep = mindreEnnPivot(pivot);
mep.quickSort();
this.quickSort();
this.settInnForan(pivot);
limSammenForan(mep);
}
}

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public void quickSort() {

    if (! tom() ) {
        Lenkeliste<T> mep = new Lenkeliste<T>();
        T pivot = this.taUtForan();
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        mep.quickSort();
        this.quickSort();
        this.settInnForan(pivot);
        limSammenForan(mep);
    }
}
```

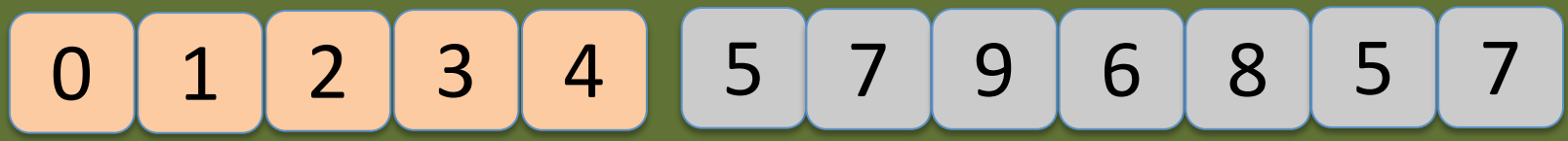


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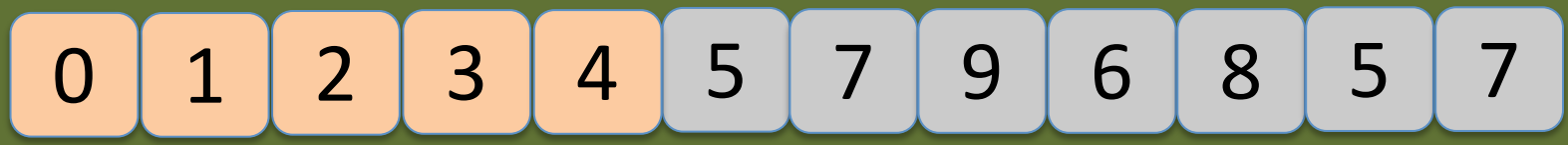
}
```

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        mep.quickSort();
        this.quickSort();
        this.settInnForan(pivot);
        limSammenForan(mep);
    }
}
```

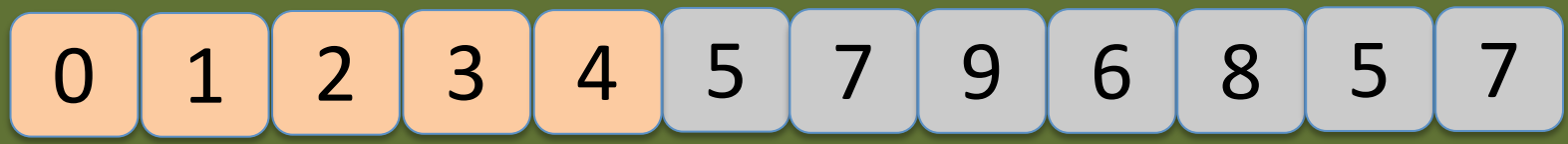

et voilà !