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// Author of question: Snorri Agnarsson
// Permalink of question: https://rise4fun.com/Dafny/CGB1z

// Authors of solution: Alexander Guðmundsson
// Permalink of solution: https://rise4fun.com/Dafny/VnB5

// Use the command
//   dafny H2-skeleton.dfy
// or
//   compile H2-skeleton.dfy
// to compile the file.
// Or use the web page rise4fun.com/dafny.

// When you have solved the problem put
// the solution on the Dafny web page,
// generate a permalink and put it in
// this file.

method SearchRecursive( a: seq<real>, i: int, j: int, x: real
1 ) returns ( k: int )
  decreases j-i;
  requires 0 <= i <= j <= |a|;
  requires forall p, q :: i <= p < q < j ==> a[p] >= a[q];
  ensures i <= k <= j
  ensures forall r | i <= r < k :: a[r] >= x;
  ensures forall r | k <= r < j :: a[r] < x;

{
  if i == j
  {
    return i;
  }
  var m := i + (j-i)/2;
  if a[m] < x
  {
    k := SearchRecursive(a,i,m,x);
  }
  else
  {

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        k := SearchRecursive(a,m+1,j,x);
    }
}

method SearchLoop( a: seq<real>, i: int, j: int, x: real ) r
returns ( k: int )
    requires 0 <= i <= j <= |a|;
    requires forall p, q :: i <= p < q < j ==> a[p] >= a[q];
    ensures i <= k <= j;
    ensures forall r | i <= r < k :: a[r] >= x;
    ensures forall r | k <= r < j :: a[r] < x;
{
    if i == j
    {
        return i;
    }
    var p := i;
    var q := j;
    while p != q
        decreases q-p;
        invariant i <= p <= q <= j;
        invariant forall r | i <= r < p :: a[r] >= x;
        invariant forall r | q <= r < j :: a[r] < x;
    {
        var m := p + (q-p)/2;
        if a[m] < x
        {
            q := m;
        }
        else
        {
            p := m+1;
        }
    }
    return p;
}

// Ef eftirfarandi fall er ekki samþykkt þá eru
// föllin ekki að haga sér rétt að mati Dafny.

```

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method Test( a: seq<real>, x: real )
  requires forall p,q | 0 <= p < q < |a| :: a[p] >= a[q];
{

  var k1 := SearchLoop(a,0,|a|,x);
  assert forall r | 0 <= r < k1 :: a[r] >= x;
  assert forall r | k1 <= r < |a| :: a[r] < x;
  var k2 := SearchRecursive(a,0,|a|,x);
  assert forall r | 0 <= r < k2 :: a[r] >= x;
  assert forall r | k2 <= r < |a| :: a[r] < x;
}
```