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Invariant I: // note: same as simple variant
{* 0≤i≤N ∧ (found = (∃k: 0≤k<i : a[k]=x)) ∧ sorted a N *}

Statement S is a sequence S1;S2:
S1: found := found ∨ (a[i]=x);
S2: i := i + 1;

Guard g:
{* i < N ∧ ¬found ∧ a[i]≤x *}


Proof PIC:
{* I ∧ g *} S {* I *}


PROOF PIC
A1: found = (∃k: 0≤k<i : a[k]=x)    // from Invariant I
A2: 0 ≤ i < N                       // from Guard g
G : wp S I  // prove that the weakest precondition holds
BEGIN ------------------------------------------

1. { see calculate wp }
    wp S I = 0≤i+1≤N ∧ ((found ∨ a[i]=x) = (∃k: 0≤k<i+1 : a[k]=x))

    PROOF calculate wp
    BEGIN ----------------------------------------
        wp (found := found ∨ a[i]=x; i:=i+1) (0≤i≤N ∧ (found = (∃k: 0≤k<i : a[k]=x)))
    1. { wp of statements sequence }
        wp (found := found ∨ a[i]=x) (wp (i:=i+1) (0≤i≤N ∧ (found = (∃k: 0≤k<i : a[k]=x)))
    2. { wp of assignment }
        wp (found := found ∨ a[i]=x) (0≤i+1≤N ∧ (found = (∃k: 0≤k<i+1 : a[k]=x)))
    3. { wp of assignment }
        0≤i+1≤N ∧ ((found ∨ a[i]=x) = (∃k: 0≤k<i+1 : a[k]=x))
    END ------------------------------------------

2. { see subproof equality }
    (∃k: 0≤k<i : a[k]=x) ∨ (a[i]=x) = (∃k: 0≤k<i+1 : a[k]=x)

    PROOF equality
    [some i]
    [some x]
    A1: (∃k: 0≤k<i : a[k]=x) ∨ (a[i]=x)
    G : (∃k: 0≤k<i : a[k]=x) ∨ (a[i]=x) = (∃k: 0≤k<i+1 : a[k]=x)
    BEGIN ----------------------------------------
        (∃k: 0≤k<i : a[k]=x) ∨ (a[i]=x)
    1. { introduce ∃-kwantor }
        (∃k: 0≤k<i : a[k]=x) ∨ (∃k: k=i : a[i]=x)
    2. { combine domains }
        (∃k: 0≤k<i+1 : a[k]=x)
    3. { we have proven equality }
        (∃k: 0≤k<i : a[k]=x) ∨ (a[i]=x) = (∃k: 0≤k<i+1 : a[k]=x)
    END ------------------------------------------

3. { reversed substitution of A1 in 2 }
    ((found ∨ a[i]=x) = (∃k: 0≤k<i+1 : a[k]=x))

4. { rewrite A2 }
    0≤i+1≤N

5. { combine 3 and 4 }
    0≤i+1≤N ∧ ((found ∨ a[i]=x) = (∃k: 0≤k<i+1 : a[k]=x))

6. { we have proved wp by equality on 1 and 5 }
    wp S I = 0≤i+1≤N ∧ ((found ∨ a[i]=x) = (∃k: 0≤k<i+1 : a[k]=x))

END ------------------------------------------
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