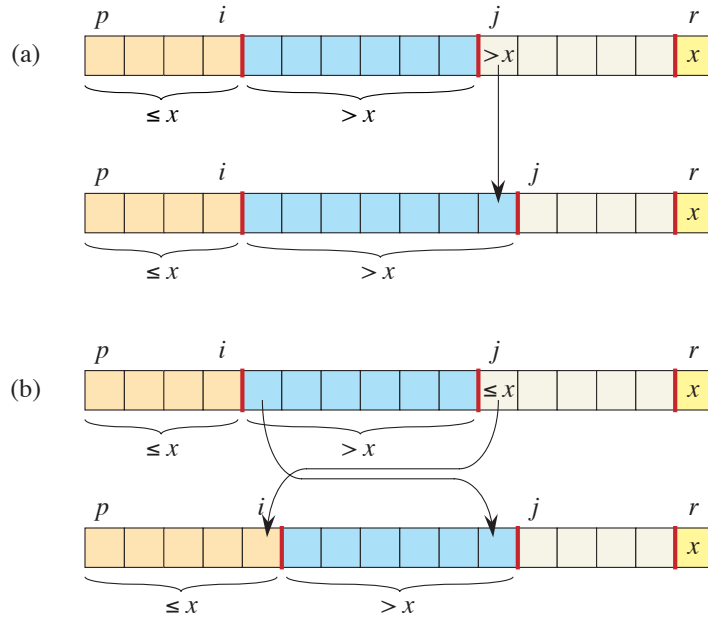**Figure 7.2**   The four regions maintained by the procedure PARTITION on a subarray $A[p:r]$. The tan values in $A[p:i]$ are all less than or equal to x, the blue values in $A[i+1:j-1]$ are all greater than x, the white values in $A[j:r-1]$ have unknown relationships to x, and $A[r] = x$.

Figure 7.3   The two cases for one iteration of procedure PARTITION. **(a)** If $A[j] > x$, the only action is to increment j, which maintains the loop invariant. **(b)** If $A[j] \leq x$, index i is incremented, $A[i]$ and $A[j]$ are swapped, and then j is incremented. Again, the loop invariant is maintained.

Exercise 7.1-3 asks you to show that the running time of PARTITION on a sub-array $A[p:r]$ of $n = r - p + 1$ elements is $\Theta(n)$.

Exercises

7.1-1
Using Figure 7.1 as a model, illustrate the operation of PARTITION on the array $A = \langle 13, 19, 9, 5, 12, 8, 7, 4, 21, 2, 6, 11 \rangle$.