

## R-5.1

The functions `size()` and `isEmpty()` run in constant time because of the member variable  $n$ . This variable can easily be returned or compared to give the results for these two functions. The function `elemAtRank( $r$ )` is also constant because of the underlying array implementation of the vector. Since we are using an array, an access at a particular index is done with a simple  $A[i]$  reference. The `replaceAtRank( $r, e$ )` function can also be done with a quick access to an index and a change of element, thus, it is also constant. However, the functions `insertAtRank()` and `removeAtRank()` take linear time due to the nature of an array. When inserting at certain rank, we must first move over (increase the rank of) every element that will follow (has a higher rank than) this element. This can take up to  $n$  moves for an array of size  $n$ . Likewise, for a removal, all of the elements that followed the removed element in the vector previous to the removal now need to be shifted down (lowered in rank). Again, this can take up to  $n$  moves.