Data Structures and Algorithms

Quicksort can be described as a recursive in-place sorting algorithm that performs a \texttt{partition()} operation on the given array and then invokes itself twice on two distinct subranges of the array.

(a) Describe the purpose, I/O parameters and effect of the \texttt{partition()} procedure and explain what the \textit{pivot} is. Pseudocode is not required. \[3 \text{ marks}\]

(b) Give pseudocode for the \texttt{quicksort()} procedure that would call the \texttt{partition()} procedure you described in \((a)\). Prove that your \texttt{quicksort()} will always terminate. \[3 \text{ marks}\]

(c) Analyse the worst-case behaviour of Quicksort and discuss possible ways of improving it. \[4 \text{ marks}\]

(d) Some researchers have suggested choosing the pivot from a randomly chosen location in the input array. Discuss the advantages and disadvantages of such a solution. How does it affect the worst-case and average-case behaviour? \[5 \text{ marks}\]

(e) Define the median of an array of \(n\) numbers. Then explain clearly how to implement a \texttt{median()} procedure that would use the \texttt{partition()} procedure you described in part \((a)\). (You may, if you wish, illustrate your answer with pseudocode.) Briefly analyse the complexity of this procedure. \[5 \text{ marks}\]