Exercise 1  \textit{(Count leading zeros)}

The $O(n \log^2 n)$ bits space and $O(1)$ query time solution for range minimum queries (RMQs) is dependent on the calculation of $k = \max \{ \ell | 2^\ell \leq j - i + 1 \}$, where $[i, j]$ is the query interval. Show how $k$ can be determined in constant time for $0 \leq i \leq j < n$ by using a data structure which only takes $o(n)$ bits of extra space. We are working in the word RAM model.

Exercise 2  \textit{(GREEDY)}

What is the worst case time complexity of the GREEDY algorithm for top-$k$ document retrieval for single-term frequency ranking?

Exercise 3  \textit{(Suffix sorting)}

Execute the induced sorting algorithm step by step for string $S=$\texttt{ananasbanana}$ (cf. slides 24-26 of Lecture 5).

Exercise 4  \textit{(Range Median Queries)}

Given an array of integers $A$ size $n$. A range median query returns for a subarray $A[i, j]$ the $\left\lfloor \frac{j - i + 1}{2} \right\rfloor$-th smallest integer in $A[i, j]$.

- Show how range median queries can be solved in $O(\log n)$ time using a $O(n \log n)$ bit data structure.
- Implement your solution.