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# Exercise Sheet 6 for Algorithms of Bioinformatics (Winter 2025/26)

***Hand In:*** *Until 2025-11-28 18:00, on ILIAS.*

## Problem 1

30 points

A circular string is a string $S[0..n)$, where letters $S[n-1]$ is followed by $S[0]$ again. A circular string is hence an equivalence class of strings under cyclic rotation. (Most prokaryotes like bacteria have circular DNA.)

Design an efficient algorithm to find an optimal pairwise alignment of two circular strings $A[0..m)$ and $B[0..n)$, i.e., the optimal alignment of any two circular shifts of $A$ and $B$.

For full credit, your solution must have running time in $o(n^3)$ for $m = n$.

## Problem 2

40 points

Given a text $T[0..n)$ and *two* patterns $P[0..m)$ and $Q[0..p)$, design an efficient algorithm to decide whether $T$ contiguously contains a *shuffle* of $P$ and $Q$, i.e., whether there is a substring $T[i..i+m+p)$ that contains $P$ as a *subsequence*, and after removing this subsequence from $T[i..i+m+p)$, we are left with $Q$.

For example $P =$ `abab` and $Q =$ `bcbc` occur as shuffled match in $T =$ `abcbbcababcbaab`.