

Algorithms in Genome Research
Winter 2025/2026

Exercises

Number 1, Discussion: 2025-November-7

1. Consider physical mapping by clone-probe hybridization.
 - (a) What are the main assumptions when the problem is modeled as the consecutive ones problem?
 - (b) Discuss experimental reasons why the assumptions may not hold in practice.
 - (c) How severe are these limitations?
2. Solve the consecutive-ones problem for the following clone-probe hybridization matrix M (if possible).

$$M = \begin{pmatrix} 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & 1 & 1 & 0 & 0 \\ 0 & 1 & 0 & 0 & 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 1 & 0 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 & 1 & 1 & 1 & 0 \\ 0 & 1 & 0 & 0 & 1 & 1 & 1 & 0 \\ 1 & 0 & 0 & 1 & 1 & 0 & 0 & 1 \\ 0 & 1 & 1 & 0 & 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 & 1 & 1 & 1 & 0 \end{pmatrix}$$

3. Is it possible to transform the following matrix M by column re-ordering into a matrix M' that satisfies the Consecutive Ones Property?

$$M = \begin{pmatrix} 1 & 0 & 0 & 1 & 1 \\ 1 & 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 1 & 1 \\ 1 & 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 1 & 0 \\ 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & 1 & 0 & 1 \end{pmatrix}$$

If not, can you identify a property that is satisfied instead?

4. Use the matrix M from the previous exercise and perform the following steps, in order to find a layout with the minimum number of runs of consecutive ones:
 - (a) Create the graph $G(M)$ and solve the Traveling Salesman Problem.
 - (b) What is the length of the shortest tour?
 - (c) What is the probe order that this tour corresponds to?
 - (d) What is the overall number of blocks of consecutive ones in this order?