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Algorithms in Genome Research

Winter 2024/2025

Exercises

Number 1, Discussion: 2024-October-25

1. Remember physical mapping by clone-probe hybridization.
   (a) What are the main assumptions when the problem is modeled as the consecutive ones problem? Will it be problematic if the assumptions are not met?
   (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?