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Discrete Mathematics for Bioinformatics (P1)

WS 2010/11

Exercises 11

1. **LARA (NIVEAU I)**

   Give a summary of the LARA algorithm for structural RNA sequence alignment based on Lagrangian relaxation. Explain the ILP formulation, the Lagrangian relaxation and how the lower bounds are derived (you can confine yourself to the pairwise case without stacking terms)

2. **Inverse Queens Problem (NIVEAU I)**

   The *inverse queens problem* consists in placing n queens on a $n \times n$ chess board, one queen per row, such that each pair is either in the same column or in the same diagonal.

   (a) Model the problem as a constraint satisfaction problem.

   (b) Solve the problem for $n = 4$ by

   - forward checking
   - partial lookahead

   assuming that the first queen is placed in column 2.

3. **Task Scheduling (NIVEAU I)**

   Suppose we have a set of activities, each with a specified duration. There are precedence constraints between the activities, such that if task A precedes task B, then task B cannot start before task A ends.

Task	Duration	Precedes
A	3	B,C
B	2	D
C	4	D
D	2	

   (a) Model the problem as a constraint satisfaction problem.

   (b) Add two artificial tasks *Start* and *End* to model the beginning and the end of the project.

   (c) Apply arc consistency to reduce the domains of the variables.

   (d) What further reduction can be obtained by fixing the end of the project to the minimum possible value?

4. **Bin Packing (NIVEAU II)**

   Consider the following variant of the *bin packing* problem:

   - Pack n items of size $g_i, i = 1, \ldots, n$, into (at most) n bins, each of capacity c.
   - Put the first m items into different bins.
   - Find the minimal number of bins necessary.

   Model the problem in

   - integer linear programming
   - constraint programming (hint: cumulative constraint)

   and compare the two models.