IOI’98 – Setubal/Portugal

Problem Portfolio

CAMELOT

1. Introduction to the Problem

Camelot is a combinatory problem conceived to test bottom-up structuring techniques to avoid repetitive computations. To avoid the state space explosion that occurs with a naïve search algorithm, the contestants should develop a disciplined way of performing the required calculations by using, for instance, tabulation techniques.

The classification given by the Portuguese Scientific Committee was as follows:

Problem type:	Geometric
Problem understanding	Medium
Algorithm effort	Hard
Implementation effort	Medium
Number of possible solutions per test	1
Several levels of testing	Yes

2. Algorithms

2.1 Overall description

The general idea can be described as follow.

For each board position (h,v), an 8x8 cost matrix $CK_{(h,v)}$ is computed. This cost matrix reflects the minimal number of moves required for a knight, at (h,v), to reach each square of the board.
Among them there are the NK cost matrices MK_i for the knights mentioned in the source problem.

For the King, the corresponding cost matrix CKK is also computed.

If no encounters were allowed, by summing up all these NK+1 matrices, a global matrix is obtained. The minima of the global matrix will define the gathering points of minimal cost.

In our case, we also need to consider, for each knight K_i, the possibility of an encounter with the King.

Therefore, each cell (X,Y) of the matrix C= K_i+ CKK contains the minimum cost of joining K_i with the King at (X,Y). We then consider, for each possible final gathering point (A,B) the minimum cost of knight travelling from each such (X,Y) to (A,B) plus the cost recorded at (X,Y) in C.

By this, we obtain a combined cost matrix MCM_i for the situation where each knight K_i meets the King. By adding each of these matrices with those of the remaining knights, we obtain the minima for the case where the chosen Knight meets the King. We then take the global minimum over all possible Knight-King matings.

2.2 Complexity

The complexity of the solution is linear in the number of knights.

2.3 Implementation

The example of an implementation is given in the PASCAL program named “Camelot.p” and in C program named “Camelot.c”.