**Special structures in hard optimisation problems**

**Deineko, V.,** Vladimir.Deineko@wbs.ac.uk, *Warwick University, UK*

Investigation of special structure in polynomially solvable cases of NP-hard problems is nowadays a well established research branch in combinatorial optimisation. Among the first papers published on this topic was the paper of scholars from Dnjepropetrovsk University - V.Y.Burdjuk and V.N.Trofimov [1]. In our talk we give a historic overview of the research in this area as well as represent new results obtained in collaboration with R.Burkard, E.Cela, B.Klinz, A.Tiskin, and G.Woeginger. We mainly concentrate on the travelling salesman problem (TSP) [2] and the quadratic assignment problem [3-4].

Special structures imposed on the matrices involved in the formulation of the problems allow one to identify polynomially solvable cases of these classical problems. Monge, Supnick, Kalmanson, Demidenko matrices are examples of known special structures that permit efficient solutions to quite a few other optimisation problems. We give a full complexity classification of the so-called four-point conditions for the TSP [4]. The mentioned above matrices are special realisations of these conditions. The special structures in matrices are dependent on the numbering of the rows and columns. So the next natural step in investigating special cases is the recognition of special structures. We describe some recognition algorithms as well as formulate problems remain to be solved.

Special solvable cases gave a raise to specially structured sets of permutations. Usually these sets contain exponential numbers of permutations though an optimal permutation can be found in these neighbourhoods in polynomial time [6].

We discuss a possibility of using algorithms designed for specially structured problems in more general settings [7-9].

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