International Symposium on Combinatorial Optimization 2008

General Information

&

Book of Abstracts

16–19 March 2008

University of Warwick, Coventry, UK

CO 2008

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Tuesday 18 March 2008

Session T1: 9:00–11:00

Parallel session T1–A (Room M1)

Session title: Network Optimization 3
Session chair: Petrică Pop

9:00–9:30	Teresa Gomes: *An effective algorithm for obtaining the set of all minimal cost pairs of disjoint paths with dual arc costs*
9:30–10:00	Lucile Denœud: *A Graph-Partitioning-Based-Heuristic for Optical Network Planning Problems*
10:00–10:30	Nicolas Sonnerat: *Galaxy Cutsets in Graphs*
10:30–11:00	Petrică C. Pop: *On The Generalized Minimum Spanning Tree Problem*

Parallel session T1–B (Room M2)

Session title: Sequencing & Scheduling 2
Session chair: Bo Chen

9:00–9:30	Ivan Rykov: *Asymptotically exact approach to solving RCPSP with one resource type*
9:30–10:00	Vitaly Strusevich: *Solving Make-or-Buy Trade-off Problems by Submodular Optimization*
10:00–10:30	Roberto Rossi: *Scheduling Internal Audit Activities: A Stochastic Combinatorial Optimization Problem*
10:30–11:00	Chris N. Potts: *Online Scheduling with Known Arrival Times*

Parallel session T1–C (Room A2)

Session title: Graphs & Networks 2
Session chair: Vadim Lozin

9:00–9:30	Bert Marchal: *A local search algorithm for determining tree decompositions of graphs*
9:30–10:00	Synara Brito: *Forest-clique partitions of cographs*
10:00–10:30	Jakub Mareček: *Zykov Revisited: Engineering an Exact Solver for Graph Colouring*
10:30–11:00	Vadim Lozin: *Stability Preserving Transformations of Graphs*

on this relaxation produces solutions that are much better than those produced by a simple heuristic currently in use, and that often turn out to be (nearly-)optimal.

Keywords: combinatorial optimization · quadratic objective function · railway optimization · train platforming · train routing · exact method · branch-and-cut-and-price

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An effective algorithm for obtaining the set of all minimal cost pairs of disjoint paths with dual arc costs

Speaker: Teresa Gomes (Department of Electrical and Computer Engineering of the University of Coimbra, INESC Coimbra, Portugal)

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Abstract: In today's telecommunications networks it is necessary, for reliability reasons, to use protection schemes involving the calculation of two (or more) disjoint paths for each node-to-node connection, especially when large amounts of traffic have to be routed in the network. This concern is particularly relevant in optical networks, namely WDM (Wavelength Division Multiplexing) networks due to the very high rates supported by lightpaths, and in the Internet using MPLS (Multiprotocol Label Switching). In this context the problem of obtaining optimal (arc or node) disjoint paths, for increasing network reliability while minimising bandwidth consumption, is extremely important.

The problem of finding k disjoint paths from s to t (two distinct nodes), in a network with k different costs on every arc such that the total cost of the paths is minimised is NP-complete even for $k = 2$, when the relationship between the k arc costs (in the same arc) is arbitrary. When $k = 2$ these networks are usually designated as dual arc cost networks.

In this paper we propose an exact algorithm for finding the whole set of arc-disjoint path pairs, with minimal cost in a network with dual arc costs. The addressed problem can be formalised as follows. Let $G = (V, E)$ be a directed network with node set $V = \{v_1, v_2, \dots, v_n\}$ and and arc set $E = \{e_1, e_2, \dots, e_m\}$ (were n and m designate the number of nodes and arcs in G, respectively), where two different non-negative cost functions (or metrics) in the arcs, are defined:

$$\eta^{(j)} \quad : \quad E \to \mathbb{N}_0 \quad (j = 1, 2) \tag{1}$$

$$\eta^{(j)}((v_a, v_b)) = c^{(j)}_{v_a v_b} \quad (v_a, v_b) \in E \tag{2}$$

The cost $C^{(j)}$ of a (loopless) path p in G with respect to metric $\eta^{(j)}$, is:

$$C^{(j)}(p) = \sum_{(v_a, v_b) \in p} c^{(j)}_{v_a v_b} \qquad (j = 1, 2) \tag{3}$$

Let path p, $p = \langle v_1, e_1, v_2, \dots, v_{i-1}, e_{i-1}, v_i \rangle$, be given as an alternate sequence of nodes and arcs from G, such that the tail of e_k is v_k and the head of e_k is v_{k+1}, for $k = 1, 2, \dots, i-1$ (all the v_i in p are different). Let the set of nodes in p be $V^*(p)$ and the set of arcs in p be $E^*(p)$. Two paths $p = \langle v_1, e_1, v_2, \dots, v_{i-1}, e_{i-1}, v_i \rangle$ and q are arc-disjoint if $E^*(p) \cap E^*(q) = \emptyset$. Two paths p and q are disjoint if $V^*(p) \cap V^*(q) = \emptyset$, and are internally disjoint if $\{v_2, \dots, v_{i-1}\} \cap V^*(q) = \emptyset$. We will say that two paths are node disjoint if they are internally disjoint.

The addressed problem is to find the whole set of pairs (p, q) of arc disjoint paths which minimise the total cost of the pair, defined by:

$$C[(p, q)] = C^{(1)}(p) + C^{(2)}(q) \tag{4}$$

where p and q have the same source and sink node.

An exact algorithm for solving this NP-complete problem will be proposed, based on a condition which guarantees that the optimal path pair cost has been obtained. This optimality condition is based on the calculation of increasingly tightened upper and lower bounds on the optimal cost. A formal proof of the correctness of the algorithm is described. Extensive experimentation is presented to show the effectiveness of the algorithm.

It will also be explained how the proposed approach can also be used for obtaining the minimal cost disjoint path pair with constraints on the maximum number of arcs allowed per path, a problem of interest in various applications, namely in telecommunication networks.

Keywords: telecommunication networks · paths with minimal cost sum · dual arc costs

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