CIRRELT

Atelier sur la conception des réseaux

Organisé en collaboration avec COMEX, le réseau belge en optimisation combinatoire

Workshop on Network Design

Organized in collaboration with COMEX, Belgium network on combinatorial optimization

Le vendredi 21 novembre 2014

Salle 5441 (présentations) et Salon Maurice-L'Abbé – Salle 6245 (lunch)

Pavillon André-Aisenstadt, Université de Montréal
2920 chemin de la Tour, Campus UdeM

Programme

9h : MOT DE BIENVENUE

9h15-10h15 : *BERNARD FORTZ*

Département d'informatique, Université libre de Bruxelles, Belgique

MODELS FOR TRAFFIC ENGINEERING IN ETHERNET NETWORKS IMPLEMENTING THE MULTIPLE SPANNING TREE PROTOCOL

The Multiple Spanning Tree Protocol (MTSP) maintains a set of spanning trees that are used for routing the demands in the network. Each spanning tree is allocated to a pre-defined set of demands. We present MIP models for the problem of optimally designing a network implementing MTSP, such that link utilization is minimized and propose a binary-search algorithm that efficiently produces near-optimal solutions for the problem.

10h15-10h30 : PAUSE

10h30-11h : *MICHEL GENDREAU*

Département de mathématiques appliquées et génie industriel, Polytechnique Montréal

SOME METAHEURISTIC APPROACHES FOR SOLVING THE FIXED-CHARGE CAPACITATED MULTI-COMMODITY NETWORK DESIGN PROBLEM

While various types of network design problems are encountered in different contexts, the core "abstract" problem that one has to deal with when designing most telecommunications or transportation networks is the Fixed-Charge Capacitated Multi-commodity Network Design (CMND) problem. In this talk, we present heuristic approaches that were developed over the last twenty-five years to tackle this problem. These encompass several different types of metaheuristics: Tabu Search, Path Relinking and Scatter Search. As far as we know, some of these approaches are still among the most effective approximate methods for the CMND. Computational results on a set of small and medium size benchmark instances will be reported and discussed.

11h-11h30 : *BERNARD GENDRON*

Département d'informatique et de recherche opérationnelle, Université de Montréal

THE IMPACT OF FILTERING IN A BRANCH-AND-CUT ALGORITHM FOR MULTICOMMODITY CAPACITATED FIXED-CHARGE NETWORK DESIGN

We study the impact of different filtering methods embedded into a specialized branch-and-cut algorithm for the multicommodity capacitated fixed-charge network design problem. Contrary to the preprocessing techniques used in state-of-the-art MIP solvers, these filtering methods exploit the structure of the problem, while being applicable to a very large class of network design problems. Three types of filtering methods are developed: preprocessing and postprocessing at each node of the tree, as well as domination rules among different nodes of the tree. Preprocessing focus mostly on feasibility testing, while postprocessing exploits reduced cost information. The techniques apply to flow and design variables, inducing variable fixing, domain reduction and cut generation, as well as early elimination of dominated nodes. Computational results will be presented on a large set of randomly generated instances.

11h30-12h : *ENRICO GORGONE*

Département d'informatique, Université libre de Bruxelles, Belgique

A COMPUTATIONAL COMPARISON OF APPROACHES TO LAGRANGIAN DUALS: THE CASE STUDY OF FC-MMCF

The focus of this work is to compare several Lagrangian relaxation approaches for solving the multicommodity capacitated network design problem (FC-MMCF). This problem frequently appears in the real world. In fact, FC-MMCF problem arises in Logists, Telecommunications and Transportation to model a plenty of applications. On the other hand, the numerical results aim at providing a benchmark for large scale MIP problems, pointing out the strengths and weaknesses of the different Lagrangian approaches.

In particular, we consider the Flow and the Knapsack relaxation for FC-MMCF problem and we solve the Lagrangian duals by using different methods coming from the differentiable optimization like (incremental, deflected, projected) subgradient-type methods and (disaggregated, generalized) bundle type methods.

12h-13h30 : LUNCH - Salon Maurice-L'Abbé (Salle 6245)

13h30-14h : *TEODOR GABRIEL CRAINIC*

Département de management et technologie, École des Sciences de la Gestion, Université du Québec à Montréal

INTEGRATING RESOURCE ACQUISITION AND REPOSITIONING DECISIONS INTO TACTICAL TRANSPORTATION PLANNING UNDER UNCERTAINTY

We focus on enhancing the capabilities of service network design models to enlarge the gamut of planning issues one can address. We thus add considerations relative to acquiring extra capacity, for the tactical planning horizon, as rented resources (vehicles) or outsourced services. We also consider the uncertainty in demand (freight volumes). We discuss modelling issues and ideas for meta-heuristics based on column generation. Preliminary computational results will also be presented.

14h-14h30 : *WALTER REI*

Département de management et technologie, École des Sciences de la Gestion, Université du Québec à Montréal

PARTIAL DECOMPOSITION STRATEGIES FOR TWO-STAGE STOCHASTIC INTEGER PROGRAMS

We propose the concept of partial Benders decomposition, based on the idea of retaining a subset of scenario subproblems in the master formulation. and develop a theory to support it that illustrates how it may be applied to any stochastic integer program with continuous recourse. Such programs are used to model many practical applications such as the one considered in this paper, network design. They are also useful for solving problems with integer recourse as many solution methods for such problems also solve one of its linear relaxations. With an extensive computational study, we have shown the significant advantages of using a partial decomposition, greatly reducing the number of optimality and feasibility cuts generated when solving a stochastic program with a Benders-based algorithm. We also show that how the partial decomposition is performed has a significant impact and point to the most performing strategy.

14h30-15h : *MASOUMEH KAZEMI ZANJANI*

Département de génie mécanique et industriel, Université Concordia

ACCELERATING BENDERS DECOMPOSITION FOR CLOSED-LOOP SUPPLY CHAIN NETWORK DESIGN

This study investigates closed-loop supply chain design in the context of used durable products with variable quality status while considering their disassembly tree. To this end, a mixed-integer programming (MIP) model is proposed in order to determine the location of different types of facilities in the reverse network while coordinating forward and reverse flows. Furthermore, legislative targets for the recovery of used products are also taken into consideration in the proposed model. A Benders Decomposition-based solution algorithm is proposed in order to solve the resulting large-scale MIP model for real-size problem instances. Several algorithmic enhancements such as adding valid inequalities to the Master Problem as well as implementing local-branching and enhanced pareto-optimal cuts are incorporated in order to speed-up the algorithm. Computational results illustrate the superior performance of the solution method

15h-15h15 : PAUSE

15h15-15h45 : *IVAN CONTRERAS*

Département de génie mécanique et industriel, Université Concordia

EXACT AND HEURISTIC ALGORITHMS FOR THE DESIGN OF HUB NETWORKS WITH MULTIPLE LINES

In this talk we present a hub location problem arising in the design of public transportation networks, where the hub-level network is composed by a set of lines. The objective is to minimize the total weighted travel time between pairs of nodes while taking into account a budget constraint on the total set-up cost of the hub network. A mathematical programming formulation, a Benders-branch-and-cut algorithm and several heuristic algorithms are presented and compared to solve the problem. Numerical results on two sets of benchmark instances with up to 70 nodes and three lines are reported.

15h45-16h15 : *MARKUS LEITNER*

Department of Statistics and Operations Research, Faculty of Business, Economics and Statistics, University of Vienna – Stagiaire postdoctoral, CIRRELT

MODELS AND EXACT APPROACHES FOR THE TWO-LEVEL DIAMETER CONSTRAINED SPANNING TREE PROBLEM

The Two-Level Diameter Constrained Spanning Tree Problem (2-DMSTP) generalizes the classical Diameter Constrained Spanning Tree Problem (DMSTP) by considering two sets of nodes with different latency requirements. In this talk we first discuss graph theoretical properties of feasible solutions to the 2-DMSTP which are based on the observation that any feasible solution to the 2-DMSTP can be viewed as a diameter constrained spanning tree that contains a diameter constrained Steiner tree. These properties are then exploited to develop integer programming formulations, valid inequalities, and symmetry breaking constraints.

In particular, we propose a novel modeling approach based on a three-dimensional layered graph. We also discuss the results of an extensive computational study which show that a branch-and-cut algorithm based on the latter model is highly effective in practice.

16h15-16h45 : *MOHAMMAD RAHIM AKHAVAN KAZEMZADEH*

Département d'informatique et de recherche opérationnelle, Université de Montréal - Étudiant de Ph.D.

MULTILAYER NETWORK DESIGN PROBLEM

Network design is a well-known class of problems in combinatorial optimization, and has numerous applications in the fields of transportation, and telecommunication. Given a potential network, which may has limited capacity links, several commodities have to be routed between different origin and destination points by constructing appropriate links between pairs of nodes. The designed network and final routing must have the minimum total cost of design and flow routing cost. Multilayer network design represents a generalized case of network design, which recently had interesting applications in the fields of telecommunication and transportation. In multilayer network design, instead of a single layer network, the network consists of multiple parallel layers. A network has to be designed in the first layer to transfer the commodities and satisfy their demands. To open a link in the base layer, a chain of supporting links (a path) in upper layer has to be opened. This dependency between designing the links in two adjacent layers, and optimizing several dependent layers in a single model, outperform the sequential optimization of single layers. This can makes huge difference in costs. To the best of our knowledge, there is no unified and general multilayer network design formulation in the literature that can cover most of the applications. In this presentation, we compare transportation and telecommunication applications, and based on this comparison, we propose a generalized formulation for MLND problem. In the proposed formulation, a set of tightening valid inequalities is proposed which are useful in context of relaxations. Network design models are a class of mixed-integer network optimization problems for which no efficient exact solution method exist that can solve them in polynomial time, except for special variants. Adding a layered structure may add to the complexity of the problem. Therefore, we propose a Lagrangian relaxation approach to solve the problem.