Bachelor Project

Czech
Technical
University
in Prague

F3

Faculty of Electrical Engineering
Department of Cybernetics

Road Graph Simplification for Minimum Cost Flow Problem

Daria Lebedeva

Supervisor: Ing. Martin Schaefer
May 2019

BACHELORÕS THESIS ASSIGNMENT

I. Personal and study details

Student's name: **Lebedeva Daria** Personal ID number: **465869**
Faculty / Institute: **Faculty of Electrical Engineering**
Department / Institute: **Department of Cybernetics**
Study program: **Open Informatics**
Branch of study: **Computer and Information Science**

II. BachelorÕs thesis details

BachelorÕs thesis title in English:

Road Graph Simplification for Minimum Cost Flow Problem

BachelorÕs thesis title in Czech:

Zjednoduġen² silniļn²ho grafu pro vĨpoļet nejlevnĐjġ²ch tokŢ

Guidelines:

Consider the minimum cost multicommodity flow problem on a road network. The computation of the problem is hard due to the complexity of the road graph. A standard approach is to consider only the main roads of the analysed area and to assume that the simplified graph of the main roads represents well the original one. The goal of the thesis is to formalize the process by explicitly considering the road network parameters and the given combinatorial problem in the simplification process.

Research the literature for approaches to graph simplification and the literature for the related flow problem.

1. Design a simplification algorithm and the mapping of the solution to the original road network.
2. Implement your solution.
3. Evaluate the performance of the solution regarding the simplification level and the problem solution quality.

Bibliography / sources:

[1] Toivonen, Hannu, S®bastien Mahler, and Fang Zhou. "A framework for path-oriented network simplification." International Symposium on Intelligent Data Analysis. Springer Berlin Heidelberg, 2010.
[2] Chekuri, Chandra, Thapanapong Rukkanchanunt, and Chao Xu. "On element-connectivity preserving graph simplification." Algorithms-ESA 2015. Springer Berlin Heidelberg, 2015. 313-324.
[3] Ruan, Ning, Ruoming Jin, and Yan Huang. "Distance preserving graph simplification." 2011 IEEE 11th International Conference on Data Mining. IEEE, 2011.

Name and workplace of bachelorÕs thesis supervisor:

Ing. Martin Schaefer, Artificial Intelligence Center, FEE

Name and workplace of second bachelorÕs thesis supervisor or consultant:

Date of bachelorÕs thesis assignment: **09.01.2019** Deadline for bachelor thesis submission: **24.05.2019**

Assignment valid until: **30.09.2020**

Ing. Martin Schaefer SupervisorÕs signature	doc. Ing. Tom§ġ Svoboda, Ph.D. Head of departmentÕs signature	prof. Ing. Pavel Ripka, CSc. DeanÕs signature

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III. Assignment receipt

The student acknowledges that the bachelor’s thesis is an individual work. The student must produce her thesis without the assistance of others, with the exception of provided consultations. Within the bachelor’s thesis, the author must state the names of consultants and include a list of references.

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Date of assignment receipt

Student’s signature

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I would like to express my deepest gratitude to my supervisor Martin Schaefer for guiding my work in the right direction, and for persistent readiness to answer any questions. I am also grateful to my boyfriend and parents for their endless moral support.

Declaration

I declare that the presented work was developed independently and that I have listed all sources of information used within it in accordance with the methodical instructions for observing the ethical principles in the preparation of university theses.

Prague, 24. May 2019

Abstract

In this work we consider the Minimum Cost Multicommodity Network Flow (MCMNF) problem as a key problem for traffic routing. The routing problem is recurring, it should be solved many times a day on a daily basis. So we present a solution that may be successfully used in the long term. We make use of a periodic demand pattern, i.e. vehicles' directions are in general recurring daily. Our improvement is based on column generation method, that allows us to reuse vehicles paths from previous days in the solution process. We achieved a 40% reduction of computational time, while the optimal solution is preserved.

Keywords: Network flows, MCMNF, column generation, traffic routing

Supervisor: Ing. Martin Schaefer

Abstrakt

V této práci se zaměřujeme na problém výpočtu nejlevnějších toků jako na klíčový problém pro řízení dopravního provozu. Tento problém se řeší pravidelně během dne, tj. nejde o nalezení řešení jednou, ale o dlouhodobý proces, ve kterém se pořád hledá řešení toho samého problémů s různými vstupy. Proto představujeme řešení, které může být úspěšně použito v dlouhodobém horizontu. Předpokládáme, že v poptávce existuje periodický vzor, tj. směr vozidel se obecně opakuje denně. Naše zlepšení je založeno na metodě generování sloupců, která umožňuje opětovné použití cest vozidel z předchozích dnů při vyhledávání řešení. Dosáhli jsme snížení výpočetního času o 40% při zachování optimality řešení.

Klíčová slova: Toky v sítích, nejlevnější toky, metoda generování sloupců, řízení provozu

Překlad názvu: Zjednodušení silničního grafu pro výpočet nejlevnějších toků

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