Scientific Computing

April 2, 2025

Announcements

→ Homework 4 due tonight!, 11:59pm

Today

→ Simulated Annealing

Office Hours:

Mon + Fri

9:30am – 10:30am

Cudahy 307

Code Review + Demos

* #13, #12, no GUI
* #5-8, TSP

Sim. Ann.
50, swap 2: 6.725
50, RB 6.262

?

300, RB
13.80

50 cities			300 cities		
SA	Swap 2	9.878	SA	Swap 2	32.828
SA	RB	6.487	SA	RB	14.362
HC	Swap 2	8.428	HC	Swap 2	29.439
HC	RB	6.412	HC	RB	14.252

HC = Hill Climbing
SA = Steepest Ascent

RB = reverse a whole block of cities

Swap 2 = swap just 2 cities

There are tons of research papers about simulated annealing applications

Journal of Heuristics, 5, 419–436 (1999)

Best Practice Simulated Annealing for the Airline Crew Scheduling Problem

THOMAS EMDEN-WEINERT AND MARK PROKSCH
Institut für Informatik, Humboldt-Universität zu Berlin, December, 14th, 1998
email: temdenwe@vss.com, proksch@informatik.hu-berlin.de

Abstract

We report about a study of a simulated annealing algorithm for the airline crew pairing problem based on a run-cutting formulation. Computational results are reported for some real-world short- to medium-haul test problems with up to 4600 flights per month. Furthermore we find that run time can be saved and solution quality can be improved by using a problem specific initial solution, by relaxing constraints "as far as possible", by combining simulated annealing with a problem specific local improvement heuristic and by multiple independent runs.

Key Words: airline crew scheduling, simulated annealing, pairing problem

1. Introduction

The need to efficiently employ human and material resources increases with the competition on a world market. In recent years, the transportation industry including airline, railway, public transit, and parcel services has taken great effort to reduce the transportation costs. In the course, vehicle routing (Daduna and Paixao, 1995; Fisher, 1995; Gendreau, Laporte, and Potvin, 1997) and crew scheduling (Rushmeier, Hoffman, and Padberg, 1995; Desrosiers et al., 1995; Desaulniers et al., 1997; Andersson et al., 1997; Caprara et al., 1997; Wren and Rousseau, 1995) have become prominent application areas of mathematical programming

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A hybrid constructive heuristic and simulated annealing for railway crew scheduling ☆

Rosmalina Hanafi, Erhan Kozan *

Decision Science Discipline, Mathematical Sciences School, Science and Engineering Faculty, Queensland University of Technology, 2 George Street, GPO Box 2434, Brisbane, Qld 4001, Australia

A R T I C L E   I N F O

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Railway crew scheduling
Mathematical programming
Constructive heuristics
Simulated annealing

A B S T R A C T

Railway crew scheduling problem is the process of allocating train services to the crew duties based on the published train timetable while satisfying operational and contractual requirements. The problem is restricted by many constraints and it belongs to the class of NP-hard. In this paper, we develop a mathematical model for railway crew scheduling with the aim of minimising the number of crew duties by reducing idle transition times. Duties are generated by arranging scheduled trips over a set of duties and sequentially ordering the set of trips within each of duties. The optimisation model includes the time period of relief opportunities within which a train crew can be relieved at any relief point. Existing models and algorithms usually only consider relieving a crew at the beginning of the interval of relief opportunities which may be impractical. This model involves a large number of decision variables and

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Large Scale Adaptive 4D Trajectory Planning

Pierre Dieumegard
Université de Toulouse ENAC
7 Avenue Edouard Belin
31055 Toulouse, France
pierre.dieumegard@outlook.fr

Supatcha Chaimatanan
Geo-Informatics and Space Development Agency
88 Moo 9, Thung Suk La
Si Racha, Chonburi, 20230 Thailand
supatcha@gistda.or.th

Daniel Delahaye
Université de Toulouse ENAC
7 Avenue Edouard Belin
31055 Toulouse, France
delahaye@recherche.enac.fr

***Abstract*—Global air-traffic demand is continuously increasing. To handle such a tremendous traffic volume while maintaining at least the same level of safety, a more efficient strategic trajectory planning is necessary. Static 4D trajectory planning with constant 4D segments, where aircraft have to stay all along their flights, ensures a strong predictability of traffic and may reduce congestion in airspace. The main limitation of this approach is linked to the 4D constraint associated to aircraft. As a matter of fact, each aircraft has to comply to this 4D segment to maintain separation from other aircraft, but this induces a real time control of the engine in order to stay all the time in this 4D segment. This could result in extra fuel consumption and shorter engine life. In this work, we present an adaptive 4D strategic trajectory planning methodology which aims to minimize interaction between aircraft at the European-continent scale. The main purpose of this work is to associate to each aircraft a 4D bubble which is adapted to the current traffic situation. When aircraft are located in low density areas, the size of such bubbles can extend (with a maximum range of 20 minutes) and when aircraft enter high congestion areas, such**

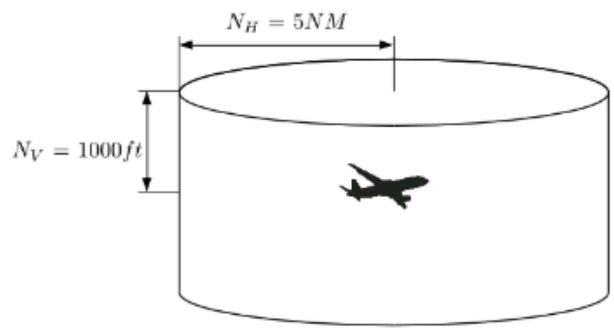

Figure 1: The cylindrical protection volume.

Eurocontrol which checks the availability of the airspace. If the request is compatible with the capacity limit, the flight plan will be accepted. Otherwise, the CFMU will suggest

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IMPROVED SIMULATED ANNEALING FOR OPTIMIZATION OF VEHICLE ROUTING PROBLEM WITH TIME WINDOWS (VRPTW)

Wayan Firdaus Mahmudy
Department of Computer Science, University of Brawijaya (UB)
Email: wayanfm@ub.ac.id

Abstrak

Vehicle routing proble with time windows (VRPTW) merupakan permasalahan optimasi kombinatorial yang banyak ditemui pada sistem distribusi permasalahan ini berkaitan dengan pengalokasian sejumlah kendaraan umum untuk melayani sejumlah konsumen, sejumlah konsumen mempunyai rentang waktu kesediaan yang berbeda dan harus dilayani dalam waktu tersebut. Paper ini memaparkan penggunaan metode simulated annealing yang diperkaya dengan beberapa fungsi khusus untuk menghasilkan solusi tetangga yang digunakan pada penelusuran are pencarian solusi dari VRPTW. Serangkaian percobaan menunjukkan bahwa simulated annealing yang diperkaya dengan fungsi-fungsi khusus dapat menghasilkan solusi yang baik dalam waktu rata-rata 82.29 detik.

Kata kunci: *Vehicle Routing Problem with Time Windows* (VRPTW), Permasalahan optimasi kombinatoria, *Simulated annealing*, solusi tetangga.

Abstract

The Vehicle Routing Problem with Time Windows (VRPTW) is a combinatorial optimization problem that exists in various distribution systems. The problem deals with allocation of vehicles to service several customers, each customer has different available time, and the vehicles must visit the customers in their available time.This paper addresses the VRPTW by using an improved simulated annealing algorithm.

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* Spring Demo — continuous
  - staying within constraints by re-tweaking
  - playing with parameters

* Knapsack Demo — discrete