3 - The dynamic multi-depot vehicle routing problem with pick-up and deliveries

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This paper considers the multi-depot vehicle routing problem which deals with two kinds of dynamic request. The first one is repair request which there is an urgent broken product need to be sent form the retail store to a depot for repair. All vehicles can provide the service immediately. The second one is sale request which there is a retail store need a product for sale immediately. The product can be sent form a depot to the store only when the vehicles have returned to depot for up load the product. A heuristic is proposed for solving the problem.

4 - A Robust Optimisation Model for Wastewater Systems Design

Maria Cunha, Civil Engineering, University of Coimbra, Polo 2, 3030-290, Coimbra, Portugal, mccunha@dec.uc.pt, *João Zeferino, Antonio Antunes*

This paper presents a robust optimisation model for regional wastewater systems design under uncertainty. It is a scenario based model aimed at determining a configuration for the wastewater systems (the sewer network and the location, type, and size of pump stations and treatment plants) that will perform well under all possible scenarios but are not necessarily optimal in any of them. The model is solved through a simulated annealing algorithm enhanced with a local improvement procedure. The application of the model is illustrated through a case study in the Una River Basin region, Brazil.

■ TA-68

Tuesday, 8:30-10:00
R19-2

Dynamic Programming and its Applications 1

Stream: Discrete Optimal Control
Invited session
Chair: *Yukihiro Maruyama*, General Economics, Nagasaki University, 4-2-1, Katafuchi, 850-8506, Nagasaki, Japan, maruyama@nagasaki-u.ac.jp

1 - Mutually Dependent Decision Processes and Their Application to the Egg Drop

Toshiharu Fujita, Graduate School of Engineering, Kyushu Institute of Technology, 1-1 Sensui-cho, Tobata-ku, 804-8550, Kitakyushu, Japan, fujita@mns.kyutech.ac.jp

In this paper, we introduce mutually dependent decision processes. In this framework, there are n processes (n > 1) and each stage reward depends on the optimal values of other processes. We give a formulation of this type of problem and derive a system of recursive equations by using dynamic programming. Moreover we apply our result to an extended model of 'The Egg Drop' introduced by S. Wagon.

2 - Strong representation of a non-deterministic discrete decision process by a non-deterministic monotone sequential decision process

Yukihiro Maruyama, General Economics, Nagasaki University, 4-2-1, Katafuchi, 850-8506, Nagasaki, Japan, maruyama@nagasaki-u.ac.jp

This paper introduces a new sequential decision process, namely non-deterministic monotone sequential decision process(nd-msdp);Ibaraki(1978) has yet introduced the process, but it is somewhat different from our definition. The nd-msdp admits a functional equations in non-deterministic dynamic programming studied by Lew(2001). Assuming that the original discrete optimization problem is given in the form of a non-deterministic discrete decision process (nd-ddp), we will show the relation between nd-ddp and nd-msdp by using the automata theory.

3 - Two Golden Duals — Complementary and Shift —

Yutaka Kimura, Systems Science and Technology, Akita Prefectural University, 84-4, Tsuchiya-Ebinokuchi, 0150055, Yuri-honjo, Akita, Japan, yutaka@akita-pu.ac.jp, *Seiichi Iwamoto, Toshiharu Fujita*

We consider two pairs of primal quadratic optimization problem and its dual problem. It is shown that optimal value and optimal solution of the two pairs are characterized by the Golden number.One pair has a Golden complementary duality, which consists of : (i)Golden optimal value, (ii)Golden solutions, and (iii)Golden complementarity between primal and dual optimal solutions. The other has a Golden shift duality, which consists of : (i)Golden optimal value, (ii)Golden solutions, and (iii)Golden shift between both optimal solutions.

4 - Bellman's Allocation Process - Conjugate Dual -

Takayuki Ueno, Department of Economics, University of Nagasaki, 123 Kawashimo-cho, Sasebo-city, Nagasaki 858-8580, 858-8580, Japan, ueno@sun.ac.jp, *Seiichi Iwamoto*

We consider the multi-stage allocation process in Chap.1, Bellman's DP from a viewpoint of duality. The (primal) process maximizes a total reward on finite-stage. The objective function is a rather complicated composite function, which contains linear terms. However we dare to convert them to constraints. Then the primal process is reduced to a maximization under linear constraints. Further by applying conjugate function/maximum transform, we transform the constrained maximization problem into a minimization one. This is a dual process. We derive Bellman equation for the dual process.

■ TA-69

Tuesday, 8:30-10:00
R19-3

OR for Development and Developing Countries 1

Stream: OR for Development and Developing Countries
Invited session
Chair: *Subhash Datta*, Centre for Inclusive Growth and Sustainable Development, M-134, SF, SouthCity I, 122007, GURGAON, Haryana, India, subhash.datta@gmail.com

1 - Integrated Energy Planning at the Block Level

Subhash Datta, Centre for Inclusive Growth and Sustainable Development, M-134, SF, SouthCity I, 122007, GURGAON, Haryana, India, subhash.datta@gmail.com

The rural development strategy must include development of energy saving technologies. The present paper investigates the energy use in a representative block in India to find out whether the local sources of energy would be able to sustain the kind of rural development envisaged. An allocation (LP) model is formulated so as to satisfy the energy demands from the available energy sources in the best possible way. The model emphasizes the use of local and renewable sources of energy.

2 - The Role of Geographic Information Systems in the Energy Sector in India

Badri Toppur, Operations Management, Great Lakes Institute of Management, Off ECR, Manamai Village, 603102, Chennai, Tamil Nadu, India, badri.t@greatlakes.edu.in

Fossil fuel energy providers dominate the energy sector. Private companies in India have reportedly been more successful in discovering oil and gas reserves in Indian territory. A play is a combination of geologic factors that make the hydrocarbon deposit or layer possible. This project paper showcases the use in India of scientific principles for locating plays, based upon base maps and thematic maps and a geographic information system (GIS). The GIS allows queries of information in the database so that identification can be made of suitable plays for drilling.