

## Optimization Concepts in Transportation Sector

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**Abstract:** Use of optimization concepts in engineering stream is diverse and while coming to civil engineering it is used in many practical applications. While peculiarly coming to transportation the same is used in number of practical applications as well as used for research studies. In this paper, focus is made on use of optimization of Pavement Management System which is used in decision making of funds raised to provide maintenance strategies. Genetic algorithm is used as a optimization tool for decision support systems. Briefly optimization of Actuated Signal Systems is also discussed.

**Keywords:** Genetic Algorithm, Optimization, Pavement Management System.

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### I. Introduction

Optimization technique is used for simple problems to more complex problems. It is important to understand the basic concepts regarding optimization to work on the same so that one can opt optimization as a tool for their decision making systems. In the next chapter two optimization concepts are discussed starting from Simplex program for solving basic mathematical form and second one being ant colony optimization is discussed briefly to understand what optimization is and how it could be implemented in real life situations.

### II. Optimization Concepts

#### A. Traveling Salesman Problem(Simple Problem)

The Travelling Salesman Problem (often called TSP) is a classic algorithmic problem in the field of computer science. It is focused on optimization. In this context better solution often means a solution that is cheaper. TSP is a mathematical problem<sup>1</sup>.

#### B. Simplex Program

The solutions are obtained for linear programs by simplex method. An example problem is solved below:

$$\text{Max } p = (1/3)x + 4y + 2z + 4w$$

Subject to

$$2x + 3y + 4z + w \leq 20$$

$$4x + 2y - 4z - w \geq 10$$

$$w - y \geq 10$$

By using Simplex Solver Method we got the following result

Optimal Solution:  $p = 41.6666666667$ ;  $x = 5$ ,  $y = 0$ ,  $z = 0$ ,  $w = 10$ ;

#### C. Ant Colony Optimization

Deneuborug and colleagues proposed a simple stochastic model that adequately describes the dynamics of the ant colony as observed in the double bridge experiment. In this model,  $\psi$  ants per second cross the bridge in each direction at a constant speed of  $v$  cm/s, depositing one unit of pheromone on the branch. Given the lengths  $l_s$  and  $l_l$  of the short and of the long branch, an ant choosing the short branch will traverse in  $l_s/v$  seconds, while an ant choosing the long branch will use  $r \cdot t_s$  seconds, where  $r = l_l/l_s$ . Ant Colony Optimization technique could be used to solve multiobjective optimization problems. It can be also used to solve simple problems such as TSP also. Algorithm has to be developed before solving any such problems.

### III. Pavement Management System

Pavement Management System is a planning tool that collects and monitors information on current pavement conditions, evaluates and prioritizes alternative maintenance, rehabilitation and reconstruction strategies. When properly implemented, it provides the necessary information for decision-makers to be well informed and to understand the long term consequences of short-term budgeting decisions.

#### **IV .Analysis Using Gads**

PMS could be solved using Genetic Algorithm technique by getting required solution in a few iteration. The time consumed would be comparatively lesser than other optimization technique.

Genetic Algorithm can be used in Matlab using GADS toolbox.

1. The optimization function in the genetic algorithm and direct search toolbox minimize the objective or fitness function
2. To find the minimum of a function from the command line  
[x fval reason]=ga(@function name, no of variables)

#### **V. Actuated Signal Systems**

Actuated Signal Systems are used in heavy traffic conditions where decision of cycle length is not based upon fixed conditions but based upon the real time conditions which prevail over a particular zonal area. Optimization of the decision making is a good option for getting optimum results rather than best or no good results. In real time situations decisions are costly so sometimes in Indian Conditions One could see mostly semi actuated signaling systems. In some other situations, we come across real time traffic for an entire area network, where optimization technique would be the best part in providing information and decision making of events. In an actuated signal design, the traffic engineer does not provide exact signal timing. Rather, a phase plan is established, and minima and maxima are set, along with programmed rules for determining the green period between limiting values based on vehicle actuations on detectors.

#### **VI .Conclusions**

The optimization techniques thus provides good platform for solving complex problems which is faced in real life situations. These techniques provide hands on tool for decision makers, planners and engineers.

#### **References**

Examples follow:

Journal Papers:

- [1]. Fwa, T.F., W.T.Chan and W.Y.Tan , Genetic Algorithm programming of road maintenance and rehabilitation, Journal of Transportation Engineering, 1996, pp. 246–253.

Chapters in Books:

- [2]. Ant Colony Optimization Textbook by Marco Dorigo and Thomas Stutzle
- [3]. Traffic Engineering, Textbook by Roger P. Roess, Elena S. Prassas, William R. Mc Shane.

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