Perishable inventory control with a service level constraint and non stationary demand

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Abstract. The determination of order quantities in an inventory control problem of perishable products with non-stationary demand can be formulated as a Mixed Integer Nonlinear Programming problem. One of the challenges is to deal with the service level constraint in terms of the loss function. The properties of the optimal solution are studied and an specific algorithms to determine (near) optimal quantities is derived.

1 Introduction

The basis of our study is a Stochastic Programming (SP) model for a practical production planning problem over a finite horizon of T periods of a perishable product with a fixed shelf life of J periods. Items of age J cannot be used at the next period and are considered waste. The stochastic demand implies that the model has random inventory variables $\boldsymbol{I}_{jt}$. To keep waste due to out-dating low, one issues the oldest product first, i.e. FIFO issuance. The model we investigate aims to guarantee a service level constraint; the supplier guarantees to supply at least a fixed percentage of the expected demand for every period. The demand that cannot be fulfilled is not backlogged.

The model has to keep track of the lost sales $\boldsymbol{X}_t$ in periods where demand exceeds the available amount of product. The service level constraint for every period is

$$E\left(\boldsymbol{X}_t\right) \leq (1-\beta)\mu_t,\ t = 1, \ldots, T. \tag{1}$$

where β represents the service level required. This constraints are non linear and represents the so called *Loss Function.* Given a random variable ω of demand, the first order loss function is defined as $\mathcal{L}_\omega(x) = E_\omega[\max(\omega - x, 0)]$. This function does not accept, in general, a closed formulation.

When considering a cost function including the costs of ordering and the costs of the amount produced, stored and wasted, an algorithm proposed can determine (near) optimal quantities.