Assignment 3, 1CM150

Optimization under uncertainty

Let us consider the situation of a stock keeping unit (sku), or item, with demand in period t,

$$D(t) = a_t + \varepsilon_t, t \geq 1 \quad .$$

We assume that a_t is known, and $\sigma(D(t)) = \sigma$. We assume that $D(t), t \geq 1$, is gamma distributed.

The fixed order costs of the item are equal to A, the holding costs are equal to h per unit in stock at the end of a period, and the penalty costs are equal to p per unit short at the end of a period. We assume that the production lead time is a constant L, which is an integer number of periods.

We want to determine a policy that controls the inventory of the item, such that costs are minimized. Unfortunately, for this general situation this is impossible due to the curses of dimensionality. Therefore we resort to the use of heuristics.

As the uncertainty is additive, we assume that the safety stock needed to cope with shortages is fixed. Thus we assume that a time-phased order point policy is used (like in MRP I logic). Furthermore we assume that we use a rolling horizon approach with a horizon T. This implies that for each time t we derive net requirements from our inventory at time t, demand forecast over the horizon, scheduled receipts and safety stock. These net requirements are the “deterministic dynamic demand” to be fulfilled over the horizon, taking into account costs. Applying some algorithm to determine the order release quantities (planned orders) over time, we implement the decision proposed by the algorithm for period t. Subsequently demand in period t realizes itself, costs are incurred at the end of the period, and the procedure is repeated. In this way we can simulate the performance of the heuristic under demand uncertainty over time. By varying the safety stock we can impact this performance for each of the algorithms mentioned below. We note here that it can be shown that the optimal safety stock setting for each algorithm is such that the Newsvendor equation holds:

$$P\{X \geq 0\} = \frac{p}{p+h} ,$$

where X is the stationary net stock at the end of a period.

The algorithms we want to test against each other are:

1. Wagner-Whitin algorithm
2. Silver-Meal heuristic
3. (s,S)-policy
4. Part-Period Balancing
5. Least Unit Cost

We consider three scenarios for the demand process:

a. a_t=100 for all t≥1
b. a_t=75 for t=1,3,5,7,…, a_t=125 for t=2,4,6,8,…
c. a_t=75 for t=1, …,10, a_t=125 for t=11,…,20, a_t=75 for t=21, …,30, a_t=125 for t=31,…,40, etc.

These scenarios represent stationary demand (a), alternating high and low demand (b), and seasonal demand (c).

We consider the following parameter values:

σ	10, 50, 100
h	1
p	9, 99
L	0, 4
A	0, 200
T	5, 10

a. Make a flowchart of the computer program that enables you to run the experiments required
b. Setup your experimental study, use the SELSP program to run the experiments.
c. Write a report on your modelling and implementation into the flowchart, and discuss your experimental findings with SELSP. The report should not exceed 10 pages including appendices.
d. Make a PowerPoint presentation of maximum 8 slides to present your findings to the course participants (cf. study guide).