Incomplete inventory information - the next challenge

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Abstract: The purpose of this lecture is to review recent developments in the analysis of partially observed optimal control problems that arise in the management of inventory systems.

Inventory control is one of the most important topics in management science/operations research. A systematic analysis of inventory problems began with the development of the classical EOQ formula of Harris in 1913. Since then, an enormous amount of literature has accumulated on inventory control problems.

One of the critical assumptions in this vast literature has been that the current level of inventory is fully observed. Some of the most celebrated results such as optimality of base-stock or (s,S) policies have been obtained under the assumption of full observation. Yet it is often the case in practice that the inventory level is only partially observed. Most of the well-known inventory policies are not only non-optimal, but are also not applicable in the partial observation environment.

The reasons for partial observation of the current inventory level are many. Inventory records or cash register information differ from actual inventory because of a variety of factors including transaction errors, theft, spoilage, misplacement, unobserved lost demands, and information delays. As a result, what are usually observed are some events or surrogate measures, called signals, related to the inventory level. At best, these relationships may provide only the distribution of current inventory levels.

In the best case, therefore, the relevant state in the inventory control problems is not the current inventory level, but rather its distribution given the observed signals. Thus, the analysis for finding optimal production or ordering policies takes place generally in the space of infinite-dimensional probability distributions.