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Online Portfolio Selection with Group Sparsity

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Abstract

In portfolio selection, it often might be preferable to focus on a few top performing industries/sectors to beat the market. These top performing sectors however might change over time. In this paper, we propose an online portfolio selection algorithm that can take advantage of sector information through the use of a group sparsity inducing regularizer while making lazy updates to the portfolio. The lazy updates prevent changing ones portfolio too often which otherwise might incur huge transaction costs. The proposed formulation leads to a non-smooth constrained optimization problem at every step, with the constraint that the solution has to lie in a probability simplex. We propose an efficient primal-dual based alternating direction method of multipliers algorithm and demonstrate its effectiveness for the problem of online portfolio selection with sector information. We show that our algorithm OLU-GS has sub-linear regret $w.r.t.$ the best *fixed* and best *shifting* solution in hindsight. We successfully establish the robustness and scalability of OLU-GS by performing extensive experiments on two real-world datasets.

1 Introduction

Investors often follow a top down approach which usually involves group selection followed by identifying the most profitable stocks within a group. One of the ways investors group stocks is by the type of business. The idea is to put companies in similar sectors together. However, not all sectors can yield profit and not all stocks in a particular sector can be profitable. Moreover, sectors might react differently during different economic conditions (Li, Vassalou, and Xing 2006; Arouri and Nguyen 2010). For example, defensive sectors like utilities and consumer staples are robust to economic downturns whereas cyclical sectors which include technology, financials, health care, etc., tend to react quickly to fluctuations in the market. We are particularly interested in taking advantage of and exploiting any underlying structure amongst the stocks for the problem of online portfolio selection.

Online portfolio selection has largely been a success story (Cover 1991; Helmbold et al. 1998; Cesa-Bianchi and Lugosi 2006; Agarwal et al. 2006; Borodin, El-Yaniv, and Gogan 2004; Das and Banerjee 2011; Li et al. 2011; Das, Johnson, and Banerjee 2013; Li and Hoi 2014) over the last two decades. These new methods for portfolio selection have been designed to not make any statistical assumptions regarding the movement of stocks (Cover 1991; Cover and Ordentlich 1996; Helmbold et al. 1998). Moreover, in a well-defined technical sense, such methods are guaranteed to perform competitively with certain families of adaptive portfolios even in an adversarial market. However, the existing work has not attempted to take advantage of the group structure that could exist amongst the stocks.

We specifically focus on using a group sparsity inducing regularizer in an online learning framework where the updates to the solutions are sparse. Such lazy updates are motivated by our desire to handle proportional transaction costs in the portfolio selection problem. An investor could incur substantial transaction costs if his portfolio changes aggressively everyday (Das, Johnson, and Banerjee 2013; Blum and Kalai 1997; Davis and Norman 1990).

In this paper, we first propose our general online lazy updates with group sparsity framework and go on to show that the online portfolio selection with sector information is a special case of this framework. Next, we introduce our OLU-GS algorithm which induces group sparsity and ensures that the updates are lazy. This results in solving a constrained non-smooth convex optimization problem at every iteration. We propose a novel alternating direction method of multipliers (ADMM) algorithm to solve this problem efficiently. In our analysis, which applies to any convex composite function with lazy updates, we show that our algorithm has $O(\sqrt{T})$ regret for general convex functions and $O(\log T)$ regret for strongly convex functions. Additionally, we prove regret bounds with respect to a shifting solution which has the benefit of hindsight.

We conduct extensive experiments on two real-world datasets and use the Global Industry Classification Standard to group the stocks into sectors for 22 years of the benchmark NYSE dataset with 30 stocks and 8 sectors and 22 years of a S&P500 dataset with 243 stocks and 9 sectors. Our experiments show that our sparse group lazy portfolios can take advantage of the sector information to beat the market and are scalable with transaction costs. It shows an interesting group switching behavior and could be especially beneficial for individual investors who have expertise in select market sectors and are averse to changing their portfolio.