When shopping online, a consumer often searches for a product by entering keywords in the search box of an e-tailer’s webpage. In response to such a search query, the e-tailer provides a list of products that match the consumer’s keywords with the intent of inducing the consumer to make a purchase. If the consumer is not familiar with the product she is searching for, she might not immediately buy from the initial list of products displayed; instead, she may use the products shown by the e-tailer to explore features of the product, form her own preferences, and make a better-informed purchase decision. For example, a consumer who wants to buy a cellphone car holder (i.e., a small device one puts on a car dash board to hold a cellphone so it can be viewed easily while driving) might start her shopping journey by typing the keywords “cell phone car holder” in an e-tailer such as Amazon’s search box. In response, Amazon then displays a number of phone holders with various features on the initial search result page. These products may spark the consumer’s interest into a specific type of phone holder such as the magnetic type (i.e., phone holders which rely on a small magnet placed at the back of the phone for suction unto the mount) even though she may not have been aware of its existence prior to her visit to Amazon’s webpage. The consumer may then refine her search by entering the keywords “magnetic cell phone car holder” in the search box. In response to this new search request, Amazon then provides an updated display of phone holders with only those of the magnetic type. And upon checking this new list, the consumer may decide to purchase one of them.

In our paper, we study the e-tailer’s optimal product display strategy when consumers may refine their search. In absence of this search refinement opportunity,
an e-tailer’s product display decision would be very similar to the assortment decision of a brick-and-mortar retailer: given limited display space, the e-tailer selects the set of products to display on his webpage, with the objective of maximizing the profit from consumers’ purchases. However, in an online setting, the e-tailer may have the opportunity to show additional products if the original product list triggers the consumer’s interest in some specific product features: as the consumer refines her search, the e-tailer is able to show products which were not displayed on the initial search page. Hence, an e-tailer should optimize product display not just for immediate purchase but also for generating further consumer interest, leading a higher chance of purchase and ultimately higher profits. As a result, the e-tailer has an incentive to display a set of products with more diversified features on the initial search result page than he would in the absence of consumer search refinement.

However, online consumers are known to be impatient so that the search refinement process comes with a cost for them. For instance, in the cell phone car holder example, it takes time and effort for the consumer to narrow down the product feature of interest (“magnetic”), modify the keyword in the search box accordingly and check the additional products shown to her on the refinement page. We refer to this cost as the consumer refinement cost.

In our paper, we formulate a consumer choice model in which consumers can refine their search at a refinement cost. We find that the optimal assortment of products to display on the e-tailer’s initial search page can be obtained by solving a number of 0-1 knapsack problems and we propose an efficient algorithm to do this in a systematic way. Further, we derive the properties of the optimal product display strategy and use those properties to answer the following research questions. First,
what is the impact of the consumer refinement cost on the e-tailer’s product display strategy? In practice, the refinement cost is a function of the design of the webpage. For example, if Amazon included a “magnetic” checkbox as a filtering option, it would be more convenient for the consumer to apply this option, leading to a smaller refinement cost. We show that, when the refinement cost decreases, the retailer should display a more diversified product set in order to trigger consumers’ interest into refining their search. Second, how should the e-tailer adjust his display strategy when products with a new feature become available? We find that the change in display strategy can be non-trivial; for example, the e-tailer does not always simply make room for products with the new feature by removing some of the original products from display. Third, how does the display capacity of the webpage impact the e-tailer’s product display strategy? We find that it can be optimal to remove some original products from display even though there are more display slots available. Thus the set of products shown when capacity is tighter is not necessarily a subset of the products shown when it is larger. Finally, how important is it for the e-tailer to consider the consumer search refinement process? In particular, how much profit will the e-tailer forgo if the product display is optimized without considering the consumer search refinement behavior? In a numerical study, we find that the e-tailer forgoes 5.8% of the profit on average and 62.6% of the profit in extreme cases, which indicates that the e-tailer can suffer very substantial profit losses from ignoring consumers’s search refinement behavior.