DESIGN OF A GENETIC ALGORITHM-BASED COUPON ADVERTISEMENT FOR ELECTRIC VEHICLES

[1]JUNGHOON LEE, [2]YEBIN HYUN, [3]YOUNGMI YUN, [4]JIMIN LEE, [5]JIN SEOK LEE, [6]GYUNG-LEEN PARK

[1,2,3,4,5,6]Dept. of Computer Science and Statistics, Jeju National University, Jeju-Do, Rep. of Korea, 63243
Email: {[1]jhlee, [6]glpark}@jejunu.ac.kr, {[2]hyb31, [3]ass9830, [5]rozkf@naver.com}, [4]eminmin113@hanmail.net

Abstract— This paper designs a real-time coupon recommendation service for moving vehicles. Not only database tables are defined but also user interfaces are prototyped for coupon issuers to upload their hot deal information instantaneously. While driving, a traveler retrieves available coupons filtered first by its location and further by the diversity and proximity criteria. To cope with the potentially tremendous computation time stemmed from exploding number of feasible recommendation sets, the genetic algorithm is exploited. Its encoding mechanism specifies coupon categories to which each item belongs, such as restaurants, cafés, charging stations, and the like. In assessing the quality of a feasible solution, the fitness function picks one element in each category, if any, one by one and builds subsets consisting of essential elements and those which are located proximately together. Finally, the set having the maximum economic gain will be provided to the customer.

Keywords— Smart Tour, Real-time Coupon Recommendation, Category-based Encoding, Genetic algorithm, Diversity and Proximity Criteria.

I. INTRODUCTION

[*]Advanced information technologies enrich tours by intelligent schedules, personalized recommendations, abundant audio-visual contents, and the like [1]. Those services are available from diverse types of devices such as PCs, mobile terminals, and cell phones, through the ubiquitous Internet connectivity. Particularly, computational intelligence contributes to the development of a sophisticated tour service, overcoming the problem of tremendous computing time stemmed from the inherent complexity of those services [2]. Moreover, the common network access enables real-time consumer-producer interactions. A service provider can publish its status to customers such as waiting queue length, today's special, and sometimes, current price. In response to this, customers can select their tour schedules to achieve a certain goal.

One of the most attractive services based on this real-time interaction is the hot-deal coupon announcement. A producer or service provider can issue an instant coupon and informs as many customers as possible any time he or she wants. For example, a restaurant may provide only a limited number of dishes and wants to sell within a specific time interval [3]. This situation can be found in a fish restaurant, where different amount of fish is supplied day by day, and the dishes must be sold while they are fresh. In the meantime, most customers are mobile, regardless of their transportation methods. While they are driving, they want to retrieve available coupons. The coupons are downloaded either in an as-wanted basis or by a push mechanism. Customers are interested in only those coupons which are nearby them.

Obviously, a customer may suffer from flooding of coupons, which he or she is not interested in at all, even though they are first filtered by the customer location. Moreover, similar coupons can be redundantly exhibited on the display device. After all, it is necessary to select a set of items capable of attracting customers. Moreover, as the number of items displayable of the mobile terminal is usually limited, it is desirable that items are interrelated and taken together. Which one to put in the coupon set is a kind of the knapsack problem, hence, the computation time may explode, when the number of coupons increases. Accordingly, we develop a genetic algorithm to find a reasonable quality answer within an acceptable time bound [4].

II. MAIN IDEA

Figure 1 depicts our service architecture. To begin with, a database table is defined to manage the static fields such as registration ID, name, and shop location of a vendor. Authorized coupon issuers can upload their hot deals through a web interface, and this will be stored in the coupon table. A coupon is valid during a given time interval, and its table entry will be purged after the expiration time. Customers, usually while driving, can retrieve such announcement by directly accessing the web page, visiting a contracted web page which embeds coupon advertisements, or preregistering on a periodic push service. In any case, the location of a customer must be provided to the coupon manager. It first searches the shops near the vehicle location, specifically, 3 *km* in its moving direction, and then joins the coupon table to find a set of valid coupons.

[*]Following are results of a study on the Leaders Industry-university Cooperation Project, supported by the Ministry of Education, (MOE).

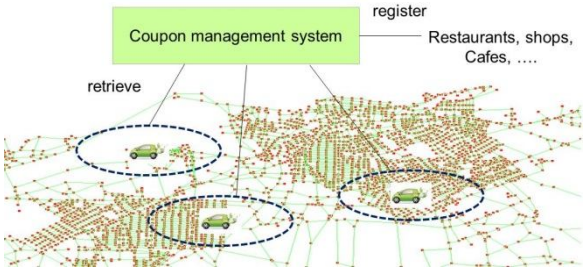

Fig.1. Location-dependent coupon retrieval

Unlike other approaches recommending within a same category, for example, tour spots, music, restaurants, and the like, our service picks a recommendation set from heterogeneous groups. Namely, there are coupons from restaurants, charging stations, diverse shops all together within a specific range surrounding the vehicle. Suppose that the appropriate number of coupons displayed to a customer is limited, say 20. This limitation comes from the display window size or possibility of user focus loss. If the total number of coupons within the range is less than this limit, the recommender just shows them all. Otherwise, some must be excluded and only those items a customer may be interested in will be provided. We want to select a set within which a customer takes as many coupons as possible.
With more candidates, the number of sets gets larger. A same shop may issue multiple coupons at the same time. Hence, it is necessary to develop a suboptimal scheme such as a genetic algorithm. This design begins with encoding of a feasible solution as an integer-valued vector. Our system assigns an ID to each coupon considering its type. For example a restaurant coupon begins with 1, a café coupon with 2, as shown in Figure 2. This strategy helps to assess how diverse a set is. Here, a set overwhelmed by same type coupons is not preferred. In addition, in a coupon selection, at most one can be picked out of multiple restaurant coupons. Café and charging station coupons are similar. After all, these coupons are grouped with a new group number. In the initialization of a chromosome, we make at least one element of a group be selected to guarantee a minimal level diversity in the initial population selection.

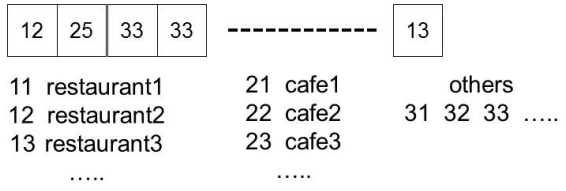

Fig.2 Encoding scheme

With this encoding scheme, genetic operators such as selection, crossover, mutation, and evaluation can be implemented just as in other applications. Here, the fitness function assesses the quality of a feasible solution in terms of achievable economic gain and proximity of subset elements. For multiple coupons to be selected simultaneously, their shops must be located close. The fitness function picks one element in each group one by one and builds subsets consisting of such essential elements and those which are located close. The number of subsets depends on the number of groups as well as the number of elements in each group, however, they are bounded by the number of chromosome length. Then, the maximum of achievable gains for all subsets is selected as fitness value.

CONCLUSIONS

Like other our everyday life areas, tour service is benefiting from ever-developing computer technologies based on intelligent algorithms and massive information management schemes. In this paper, we have conceptually designed a tour coupon recommendation service which announces the hot-deal information to the interested travelers and further narrows the selection complexity, by enhancing the diversity and proximity of items in a recommendation set. To overcome the time complexity faced in most recommendation services, a genetic algorithm is exploited, defining an encoding scheme capable of representing the category to which a coupon belongs. The fitness function measures the maximum economic gain among feasible subsets in a chromosome. This strategy enhances the possibility that multiple items will be simultaneously taken by a customer in a single recommendation set, still allowing an additional coupons to be picked.
As future work, we are planning to extend our design to the smart tour for electric vehicles [5]. Due to their digital nature, more recommendation context information, including current locations and state-of-charger, is available.

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