Recommender systems for carer guidance

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***Abstract*—The research of the paper is devoted to present of an R&D of two recommender systems in carer guidance for Việt Nam middle school students and one for testing a paper [1] technique for data obtained in National research Irkutsk state technical university. The first system is built on the base of John Holland's six personality types theory and collecting university students' opinions on their study conditions, and the second one relates data from a social network and faculty enrollment documents. Both systems describe new user (an entrant or a pupil) properties by distances to student groups and then presents top-N universities/departments as a recommendation. Techniques of overcoming "cold start" problem and other ones in this domain are considered.**

***Index Terms*—recommender system, cold start, carer guidance, user group description, machine learning**

I. Introduction

In the countries with predominantly young population, such as Việt Nam, the demand of young specialists is high. While still a high school student, one have to make a decision about a career. Career choice depends on many factors such as personal interests, academic ability and employment opportunities available after the graduation. Therefore, choosing the right carer is not an easy task. In fact, quite often graduates remain unemployed for a long time or do not work in their specialties mastered in an educational institution. This leads to inefficient use of state funds, their irrational distribution. That's why the choice of an university after receiving a certificate of maturity is very important. Choosing a suitable university results in an increase students' study productively, as they work and practice with enthusiasm. Supporting the decision activities will give a better chance of achieving students' goals in the future.

In Tables 1 and 2, we present the result of interest assessment to career guidance and relevance of improving of the guidance system. Tables show that there is a real problem of carer guidance and middle school students are very interested in improving the corresponding activities.

At present, with the development of the Internet, the search for information about universities is sufficiently efficient. However, having a huge amount of information, selecting substantive information is a difficult task. Recommender systems (RS) have emerged as a decision support tool, providing users with the most useful and personalized variants for goods and services. The functioning of RS is based on filtering information with respect to a set of known properties of objects and users. For example, RSs are used to assess the users' preferences for goods and services (songs, films, video clips, books, articles, *etc.*), which have been not previously given ratings by the user trying to make a choice.

RSs are also quite successfully used in many business spheres, such as entertainment: offering songs to listeners (*e.g.*, the LastFM system – www.last.fm), offering films (the Netflix system – www.netflix.com), recommended videos (the YouTube system – www.youtube.com); in education and training (learning resources, books, articles, site addresses), in intelligent systems of teacher assistants (predicting students' learning capabilities). RSs are the field of active IT research since 2007. Our literature and technologies review is in [2].

Teaching experience of the first author of this paper in secondary school shows the relevance of the problem of choice of a profession. This research, being the results of a master thesis, is dedicated to the development of an RS that allows students (applicants) to receive recommendations when taking career decisions. The aim of the research is development of a RS for supporting students in their carer decision making.

TABLE I
Interest assessment to the carer guidance in Việt Nam, Hà Tĩnh city

Interest level	Count of votes	Ratio, %
Very interested	218	51.9
Relatively interested	155	36.9
Less interested	36	8.6
No interest	11	2.6
Total	420	100

TABLE II
Questionary results of middle school students on need for improvement of the carer guidance system

Answer option	Quantity	Ration, %
very necessary	272	64.8
necessary	145	34.5
no necessity	3	0.7
Total	420	100

The resulting RS prototype has two options for producing recommendations. The first one is realized on the base of John Holland theory [**?**], according to which most people have one of six personality types. After determining the type, a set of corresponding universities are produced. The second one is an aggregation of questioning data about concrete universities obtained from students already being taught there. The recommendations, then, are generated by means of collaborative filtration (CF) based on users' profile comparison. Thus, the RS prototype combines two approaches: using expert knowledge and CF.

II. Technique of construction for the RS helping with the carer choice

Recommender systems [4] are decision support information systems designed to assess the user's level of interest in a particular product or service (object) based on available information about user and object. The RS development industry began to actively develop with the emergence of online sales services, and now it is one of the active areas of development of decision support systems, a direction of artificial intelligence, focused primarily on commercial use, as well as on solving problems of increasing the productivity of searching for relevant information. A profession is the object of RS recommendation production. Let us consider the development technique for RS construction from the point of view of solving the standard set problems and challenges.

Development of the RSs is aimed at solving the following set of problems [3]:

1) Increasing the sales of a product
   - a number of commodities sold,
   - organizing wider range product sales;
2) Increasing user satisfaction and/or loyalty;
3) Better understanding user needs;
4) Better products offers with respect to the user needs;
5) Selection of sets of products for users with a common properties
   - "good" ones, and
   - product groups, having a common usability properties;
6) Mining the classes of products, structuring the RS product domain, and
7) Generate a continuity of recommendations using the classification;
8) Rectifying user profile, *e.g.* with targeted questioning;
9) For the users having no goal to make choice, but searching for an expert opinions,
   - Analysis of other users impact on a choice,
   - Formalizing opinions,
   - Recommending opinions.

In this context, the RS is aimed at solving 4–7-th problems. This set defines the methods of RS proposal generation and algorithms, which have to be implemented. As we can see, the universities and their departments can be distributed on various carer directions by two ways: with the use of expert knowledge, when experts analyze a departments' properties and relate them to a direction, and with use of onions of the students (users who already "consume" a product). In the second case, a good opinion of a user on a department (product) creates or solidifies a corresponding relation. In the same time, a group of students positively characterized a department form a group of "similar" users.

The main problem solved during the R&D is "*cold-start*" *problem*. For RS based on CF, the similarity of user profiles in terms of sets of specified characteristics are performed. Content filtering RS compare products. In both cases, RS cannot generate recommendations if it does not have enough information about users or products. The cold-start problem arises at the first stages of RS functioning and when a new user's behavior had not been observed sufficient time, *i.e.*, the RS have no data about his preferences, or user's profile contains no useful information for a comparison. The same situations arises for a new product, *e.g.* there is no user bought the product, and no responses were given. In this system explicit information collection has been realized for solving cold-start problem in CF, and John Holland's theory was used as initial profile data filling in, including the input data for the Holland's questionary.

The simplest technique for user profile data collection and usage is so called *impersonalized acquisition*. Recommendations are generated for an "average" user related to a nearest group od users. An RS gives top-N products for the group, efficiently ignoring personal preferences. The approach can be developed to support personal data with construction of subgroups of the groups relating them to a set of personal characteristics. This may lead to unwillingness giving personal data of users and impossibility to generate proposals when a user cardinally changes his/her preferences. In this system, as our intention is a detection of a direction of a carer, impersonalized approach seems to give sufficient quality result.

The *scalability problem*. Scalability is a property of software systems to be able to cope with the load prescribed by design, as well as with increased load if additional information–communication and computing resources are available. For a simple RS with several users and products, there is no need to maintain scalability, and algorithms such as "nearest-neighbor" are widely used for assessing interests as the combinatorial space is not large.

Thus, to construct carer choice RS prototype, we have chosen to collect impersonalized data, structure users with respect to their university/department preference and user profiles by means of collaborative filtering, use questionary and expert approach for initial user profile filling in.

A. Holland's six types TODO

Realistic, Investigative, Artistic, Social, Enterprising, Conventional.

In order to determine the type one must answer 54 questions, the questions are evenly distributed on this six types. For each question, a 0-4 scores are to be set depending on the degree of manifestation. The store 0 corresponds to "no manifestation" was mentioned of a kind, and score 4

denotes “always manifestative”. For each type the scores of the corresponding nine questions are collected, and the type is figured out as a type with the maximum score sum. Student profiles store all answers and estimates, just for a further system development.

III. Preliminary Data Processing

In realty RS, two program agents are implemented, which are executed on an event occurrence. The first one starts by timer of web browser and implements issuing user positive evaluation, if user spends some time viewing a page of a realty object. The second one, located at the server side, is activated if the first one raised event of a positive evaluation. Server agent receives the evaluation and may start recalculation of estimates for recommendations if there are enough computational resources.

All data are stored in a database, which structure is represented as objects in Fig. **??**. The central entity is `IOffer`, representing the offer of a realty object. The information on an object, which is independent of an offer, is stored as `IObject`-object. The object structure corresponds to standard Yandex and Google form of real estate representation.

IV. Database structure

V. Implementation

The RS is a web-application implement in Django MVP[1] framework, MySQL has been chosen for data storage. Python programming language is the main glue subsystem, gathering web-application and recommender unit in one system. For carrying out experiments with data, a Jupiter subsystem was included in the system as well.

User roles are administrators, anonymous and regular user. Administrator can manipulate user accounts and any raw data. Anonymous users can register, view information on universities, taught courses and professions. Regular registered user can obtain recommendations, rate universities, add an university to his/her preference list. The use-case diagram is shown in Figure 1.

```
from django.db import models
from django.contrib.auth.models import AbstractUser

# User
class NGUOIDUNG(models.Model):
IdUser = models.AutoField(primary_key=True)
TenNguoiDung = models.CharField(max_length=20, null=False)
HoTen = models.CharField(max_length=200, null=False)
MatKhau = models.CharField(max_length=200, null=False)
Email = models.CharField(max_length=200, null=False)
Quyen = models.IntegerField(null=False)
GioiTinh = models.BooleanField(default=False)
SDT = models.CharField(max_length=15, null=True)
NgaySinh = models.DateTimeField(null=False,
  default="1999-01-01")

# Interests
class TINHCACH(models.Model):
IdTinhCach = models.AutoField(primary_key=True)
Loai = models.IntegerField(null = False)
ChiTiet = models.CharField(max_length=1000, null=False)
```

[1]Abbreviation of Model-View-Controller programming pattern

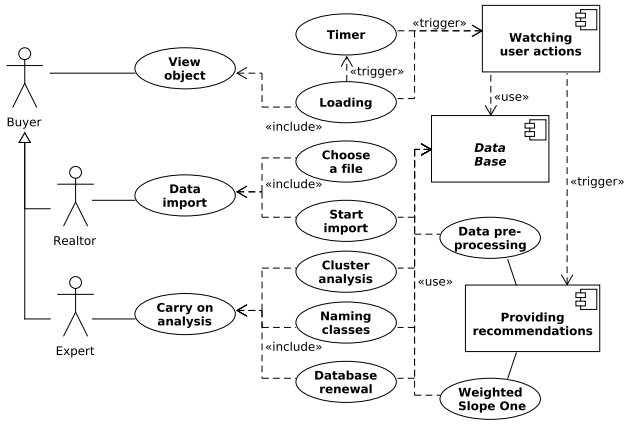

Fig. 1. Use case diagram for real estate RS [TODO: UPDATE to CDT’s thesis]

```
# List university

class TRUONG(models.Model):
IdTruong = models.AutoField(primary_key=True)
TenTruong = models.CharField(max_length=1000, null=False,default="")
ChiTiet = models.CharField(max_length=1000, null=True)
ChiTietFull = models.CharField(max_length=1000, null=True)

# Vote for an university
class VOTE(models.Model):
IdVote = models.AutoField(primary_key=True)
IdTruong = models.IntegerField(null=False)
IdUser = models.IntegerField(null=False)
Point = models.IntegerField(default=0)

# List of favorite universities
class FAVORITE(models.Model):
IdFavo = models.AutoField(primary_key=True)
IdTruong = models.IntegerField(null=False)
IdUser = models.IntegerField(null=False)
```

For representing answers on Holland’s questionary and intermediate data two tables added.

```
from django.db import models
# Create your models here.
class ListUni(models.Model):
name = models.CharField(max_length=100)
description = models.TextField()
excerpt = models.TextField(max_length=300)
pictrure = models.ImageField(upload_to='Uni_picture')
group = models.IntegerField(default=0)
def __str__(self):
return self.name
class list1(models.Model):
name = models.CharField(max_length=100)
anddress = models.CharField(max_length=200)
description = models.TextField()
excerpt = models.TextField(max_length=300)
pictrure = models.ImageField(upload_to='Uni_picture')
group = models.IntegerField(default=0)
def __str__(self):
return self.name
```

TODO Activity diagram

VI. Recommendations Generation

VII. Web Applications

VIII. Discussion

Comparing these two approaches to the RS R&D ....

The first approach ... allowed collecting data in the runtime of the RS and also used J. Holland's theory, which has been used for decades for carer guidance, ...

The second approach ... is more useful for solving problems 1, 6,7,9 of the list of Section II.

IX. Conclusion

In this brief narration of the results of two master theses, information recommender systems (RS) were developed to support the choice of a profession for students in Viet Nam and Irkutsk, Russia. The following tasks have been solved:

1. The subject area of RS, assistance in choosing a profession (carer guidance), have been analyzed; typical problems were recognized and their solution method were proposed.

2. The theory of John Holland in carer guidance was applied for high school students in Ki Lam High School, Ha Tinh, Viet Nam.

3. High school students of last courses tested the universities rating setting playing role of university students.

4. A methodology for calculating recommendations for carer guidance, based on the method of collaborative filtering and expert evaluation, is proposed. The technique has been implemented with Python modules.

5. Implemented an RS subsystems in the Python programming environment based on the proposed techniques and data structures; This Rs was tested by younger students of the Viet Nam school.

The resulting RS MVP[2], extended with automatic university data crawling and more efficient algorithms, is to be deployed in the school.

The source code is located at Github.com URL: https://github.com/tranducthe/diplom_CollaborativeFiltering.

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