Modelling the Human Values Scale in Recommender Systems: A first approach

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Abstract. The objective of this paper is two-fold. The first is to develop a methodology capable of extracting the Human Values Scale (HVS) from the user, with reference to his/her objective, subjective and emotional features, in order to improve the adaptation of user models to open environments, particularly in recommender systems. For this purpose a Coherence function is defined based on the user's emotional features profiled from his/her previous interactions with the system. This function is the mapping between the user behaviour and the relevance given by him/her in each life cycle of interactions. The second objective is to present preliminary results obtained from a case study using the objective, subjective and emotional attributes in the banking domain where the methodology was tested.

Keywords. Human Values Scale, Recommender Systems, User Modelling.

1. Introduction

Personalization of services using a user's Human Values Scale (HVS) can improve his/her satisfaction. According to [6], the information society will be followed by a society in which individuals will prioritize their decisions in interactions that involve a high degree of emotion, which will be a relevant issue in their values scale. Therefore, we are witnessing a cyclical transformation in society affecting its values scale. Generally speaking, rational decisions will be replaced by decisions with a high emotional component.

In traditional psychology [8] the HVS is treated as the set of desirable and non-situational goals whose significance can vary from one person to another and govern their life like a set of individual principles.

However, in the next stage of recommender systems the user of the future will be the situational human being who makes decisions not only based on his/her preferences, tastes and interests, but also based on his/her perceptions about them. These perceptions are what we call user *emotional sensibility* in each situation.

In recommender systems, emotional sensibility can be defined as the *emotional response of the user* to the suggestions, advice or predictions of interest made by the system in each particular context, obtained through the *emotional component* of the *Smart User Model (SUM).* A *SUM* is an adaptive user model that captures the evolution of a user's emotions. The emotional component of the *SUM* is a set of attribute-value pairs representing the *emotional state* of a user in a given moment [2].

Our research is focused on the analysis of HVS using the Schwartz Value Survey (SVS) [9], which can take advantage of the *SUM* through its emotional component in

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order to define a coherence function that responds with more exactitude to preferences and interests of the user. This kind of function can influence the user's perception and final decision making.

In this paper, we intend to demonstrate that the values-scale changes according to user life cycles, are mediated by intelligent agents that act on behalf of a user in recommendation processes.

The paper is organized as follows. In Section 2 a brief introduction of work related to the topic of the Human Value Scale is presented. In Section 3, we stimulate the study of the HVS in user modelling as an important issue in research into emotional response in recommender systems. We continue in Section 4 with an experiment that allows the relation of emotional component of the *SUM* with the HVS to be understood. Then, in Section 5 we define a function to measure the values scale according to the emotional component of the *SUM*. In Section 6, we compare two life-cycles of the user. We finish in Section 7 with some conclusions and suggestions for future work.

2. Related Work

Research studies [7] have demonstrated the influence of human values over the perception and decision making of human beings. These studies reveal the value structure of each individual, in particular the values to which a greater or smaller importance is assigned, as this plays as determining a role in perception as in decision making.

The reliability and validity of the SVS have been demonstrated in several works [4]. The SVS [9] consists of forty items, each one associated with an asymmetric scale from 1 (opposed the personal values) to 6 (of supreme importance) indicating the importance of this value as a guiding principle in the user's life. The survey items are distributed among ten universal dimensions which respond to different underlying motivations of the values integrating them. These dimensions are: power, achievement, hedonism, stimulation, self-direction, universalism, benevolence, tradition, conformity and security. We called these dimensions Meta-attributes.

The procedure for scoring of agreement to the SVS is the following: 1) Apply the SVS; 2) To obtain the personal score in each typology, add the points that have been assigned to questions associated to each typology; 3) Divide the result by the number of questions associated to each typology; 4) Mark the score of each typology in the corresponding axis of the Dynamic Structure of Values (See Figure 1); 5) Connect the points until a polygon of 10 sides is completed.

This theory allows the HVS of a user of recommender systems to be developed from existing user models, particularly from the *SUM*s.

HVS will be applied to the user in incremental form by the SUM.

3. The Human Values Scale in User Modeling for Recommender Systems

User Modeling (UM) represents assumptions about the user's knowledge, beliefs, preferences, and other user characteristics [5]. One of the most important challenges in UM is building user models to be used in different domains across several applications. It is, therefore, a model of a user at a meta-level, opposed to a profile of a specific user. HVS can be introduced in UM to respond to this challenge. The values scale in UM can

be defined as the set of *rules* that manage the *behaviour* of a flexible autonomous entity, which is related with the emotional factor of the user.

In our research, such emotional information is useful for the recommendation process since we can deduce that the values scale can be applied to autonomous and flexible entities, for instance a multi-agent *SUM [2]*.

Values act as a central means of rationalizing action within the human mind. Given a goal, values dictate the way in which the goal will be accomplished [1].

The HVS is represented by goals (implicit or explicit) which are conscious of the needs of every flexible and autonomous social entity.

The HVS is an integral approach to UM and can take advantage of the *SUM* using its emotional component.

4. Case Study. Mapping the SUM in User Values Scale.

We illustrate the proposed methodology through a recommender system of banking services. The user, Juan Valdez, asks the system to recommend the services of a bank taking into account his *objective* (O), *subjective* (S) and *emotional* (E) attributes acquired by his *SUM* (see Table 1). The method creates a mapping between Juan Valdez's *SUM* and his HVS that allows the coherence function between his preferences and actions to be found.

The procedure to obtain the user HVS is the following: First, the values of each attribute in the *SUM* are normalized in the interval [0, 1] [2], in order to obtain the values in Table 1.

Table 1: Normalized values of each attribute (two Juan Valdez life-cycles).

Attribute	Type	Value		Normalized Value	
		Cycle 1	Cycle 2	Cycle 1	Cycle 2
Account Number	O	12345678	12345678	12345678	12345678
Name	O	Juan Valdez	Juan Valdez	Juan Valdez	Juan Valdez
Age	O	26	32	26	32
Sex	O	Male	Male	Male	Male
Civil State	O	Single	Married	Single	Married
City	O	Girona	Girona	Girona	Girona
Region	O	Catalonia	Catalonia	Catalonia	Catalonia
Country	O	Spain	Spain	Spain	Spain
Occupation	O	Computer Sc	Computer Sc	Computer Sc	Computer Sc
Monthly Income	O	2,500.00 €	3,200.00 €	2,500.00 €	3,200.00 €
Tangible	S	Normal	High	0.50	0.91
Responsibility	S	Yes	Yes	0.75	0.75
Change Propensity	S	Normal	Normal	0.50	0.50
Cultural Level	S	High	High	0.91	0.91

Attribute	Type	Value		Normalized Value	
		Cycle 1	Cycle 2	Cycle 1	Cycle 2
Solidarity	S	Yes	Yes	0.75	0.75
Security	S	Normal	High	0.66	0.91
Economic capacity	S	Normal	Normal	0.50	0.50
Innovator	S	Normal	Normal	0.50	0.50
Technology	S	Normal	Normal	0.50	0.50
Mobility	S	Null	Normal	0.16	0.50
Trust	S	Much	Much	0.87	0.87
Satisfaction	S	Normal	High	0.50	0.75
Comfort	S	Null	High	0.13	0.75
Personal treatment	S	Good	Good	0.83	0.83
Saving	S	Yes	Yes	0.75	0.75
Carefree	E	No	No	0.09	0.09
Satisfied	E	No	No	0.09	0.09
Warm hearted	E	Weak	Normal	0.09	0.50

Second, values for each subjective and emotional attribute are obtained according to [2]. Then we classify each attribute with its corresponding *Meta-Attribute* and associated question of the SVS (see Table 2).

Table2: Mapping between the normalized *SUM* and the meta-attributes of the SVS

Attribute	Normalized Value	Qualification (SVS)	Meta-Attribute	Associated Question
Tangible	0.50	3	Achievement	13
Responsibility	0.75	6	Benevolence	18
Change Propensity	0.50	3	Achievement	32
Cultural Level	0.91	6	Tradition	25
Solidarity	0.75	6	Universalism	29
Security	0.66	4	Security	5
Economic capacity	0.50	3	Power	17
Innovator	0.50	3	Self-Direction	1
Technology	0.50	3	Self-Direction	1
Mobility	0.16	1	Stimulation	6
Trust	0.87	6	Security	14
Satisfaction	0.50	3	Conformity	36
Comfort	0.13	1	Hedonism	26
Personal treatment	0.83	6	Tradition	38
Saving	0.75	6	Achievement	24
Carefree	0.09	1	Conformity	16
Satisfied	0.09	1	Hedonism	10
Warm hearted	0.09	1	Benevolence	12

If there are several attributes corresponding to one associated question then we obtain the average of the qualifications of the repeated meta-attributes. For instance, in our case, question one appears two times, the reason why the *Self-Direction* meta-attribute obtains value equal to 3.

Third, we sum up the values assigned to each associated question corresponding to each meta-attribute (see Table 3).

Table 3. *SUM* Qualification

Attribute	Normalized Value	Qualif. (SVS)	Meta-Attribute	Question Associated	Qualif. Meta-Attribute
Innovator-Technology	0.50	3	SelfDirection	1	3
Warm hearted	0.09	1	Benevolence	12	3.5
Responsibility	0.75	6	Benevolence	18	
Carefree	0.09	1	Conformity	16	2
Satisfaction	0.50	3	Conformity	36	
Mobility	0.16	1	Stimulation	6	1
Satisfied	0.09	1	Hedonism	10	1
Comfort	0.13	1	Hedonism	26	
Tangible	0.50	3	Achievement	13	4
Saving	0.75	6	Achievement	24	
Change Propensity	0.50	3	Achievement	32	
Economic capacity	0.50	3	Power	17	3
Security	0.66	4	Security	5	5
Trust	0.87	6	Security	14	
Cultural Level	0.91	6	Tradition	25	6
Personal treatment	0.83	6	Tradition	38	
Solidarity	0.75	6	Universalism	29	6

Fourth, we divide the result between the number of times that appears the meta-attribute and we normalize (see Table 4).

Finally, we draw the mapping normalized by each meta-attribute in the corresponding axis of the Dynamic Structure of Values, obtaining Figure 1.

Table 4. Juan Valdez HVS in life's cycle 1

Meta-Attribute	Qualification (SVS)	Normalize Qualification
Self-Direction	3	0.50000
Benevolence	3.5	0.58333
Conformity	2	0.33333
Stimulation	1	0.16667
Hedonism	1	0.16667
Achievement	4	0.66667
Power	3	0.50000
Security	5	0.83333
Tradition	6	1.00000
Universalism	6	1.00000

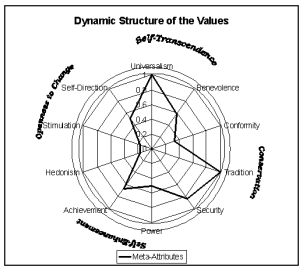

Figure 1: Juan Valdez's HVS graph in life-cycle 1

According to HVS obtained through this methodology, we realize that Juan Valdez is a person who puts emphasis on preoccupation for the well-being of others. In addition, he is a person who fights for stability and conservatism, due to the superiority of the value Tradition and Security. Thus, the banking recommender system would recommend to Juan Valdez traditional banking services or products, for instance, those that do not have high risk, conservative banks and non-innovative banks. In addition, these products or services would in some way be involved in social programs.

Considering the previous example, we can mathematically express the function that will allow the degree of coherence to be identified between 2 or more life cycles of the user in the following way:

Considering the Dynamic Structure of Values calculated for Juan Valdez, we observe an irregular polygon is drawn. We will obtain the area under the curve, calculating the area of each triangle with Equation (1), according to Figure 2.

$$A_t = \tfrac{1}{2} A \cdot B \cdot sen\theta \tag{1}$$

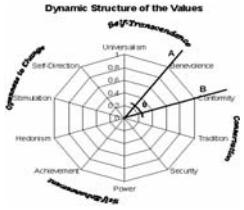

Figure 2. Area under the curve of the triangle

Where:

A_t = Area under the curve of a triangle

A = Side A, is the qualification of Meta-attribute X $f(x)$

B = Side B, is the qualification of Meta attribute X+1 $f(x+1)$

$Sen\theta$ = Angle formed by the triangle

In order to know the area under the curve of the polygon, it would have:

$$VS = \sum_{i=1}^{i=10} \tfrac{1}{2} f(x_i) \cdot f(x_{i+1}) \cdot sen\theta \tag{2}$$

Where *VS* is Juan Valdez's Values-scale in a life-cycle.

Replacing the values in Eq. (2), Juan Valdez's Values-scale in a life-cycle is:

$$VS = \frac{1}{2}(1 \cdot 0.58333) 36° + \frac{1}{2}(0.58333\ 0.333333) 36° + \frac{1}{2}(0.333331) \cdot 36° + \frac{1}{2}(1 \cdot 0.833333) 36° + \frac{1}{2}(0.833333\ 0.5) \cdot 36° + \frac{1}{2}(0.5 \cdot 0.666667) 36° + \frac{1}{2}(0.666667\ 0.166667) 36° + \frac{1}{2}(0.166667\ 0.166667) 36° + \frac{1}{2}(0.166667\ 0.5) \cdot 36° + \frac{1}{2}(0.5 \cdot 1) \cdot 36°$$

$$VS = 1.004133$$

Therefore, the normalized value of Juan Valdez's Values-scale (VS_n) in this cycle is computed using the following Eq. (3):

$$VS_n = \frac{VS}{VSm} \tag{3}$$

Where:

VS = The Values-scale VS_m = Maximum value of Values-scale = 2.93

Therefore, replacing values in Eq. (3): $VS_n = \frac{VS}{VSm} = \frac{1.004133}{2.93} = 0.342708$

Additionally, the recommender system calculates automatically the weight which in this case is 0.43

5. Case Study. Defining the Coherence Function based on the SUM

We can define the HVS using a function that has two arguments: a *behaviour-based function* that represents the value scale of the user and a *weight* that represents the relevance that the user gives to a set of situations in every cycle of his/her life. The behaviour-based function is developed with the emotional factor (moods) of the user using his/her emotional component in the *SUM* in order to give a semantic value to the feelings in particular situations of his/her life.

This function can be validated by assigning degrees of *relevance* (weights) to each *action* (transaction) of the user in the recommender system, similarly to the way the user does the corresponding actions in his/her life. This relation between the behaviour-based function and the relevance of the user in each life cycle is called the *Coherence function (Coh)*. This mapping will reflect his/her actions in order to choose a suitable recommended item/service.

The *Coh* function can be formally defined as shown in Equation:

$$Coh_C = \left\langle Vs_n , w_{c_i} \right\rangle \ \forall c_i \in C; \tag{4}$$

Where:

Coh_C: Coherence function of the user for the cycle *i.* This value is between [0, 1].

Vs_n: Behaviour-based function for the cycle i of the user.

$C = \{c_1, c_2, ..., c_k, ..., c_n\}$: Represents the user's life-cycles.

w_{c_i}: Weight or relevance that the user gives to particular situations according by his/her actions in the cycle *i*. Weight is initially provided by experts, and later, on

according to the actions of the user, it is calculated automatically by the recommender system (according to [3]) as it follows up on the changes of the HVS in the user's life-cycles.

6. Case Study. Contrasting User Life-cycles based on HVS.

In order to compare Juan Valdez's life-cycles, the SUM is actualized (see Table 1, in cycle 2). The following table of values was obtained.

Table 6. Juan Valdez's HVS in life-cycle 2

Meta-Attribute	Qualification (SVS)	Normalize Qualification
Self-Direction	3	0.500000
Benevolence	4.5	0.750000
Conformity	2.5	0.416667
Stimulation	3	0.416667
Hedonism	3	0.500000
Achievement	5	0.833333
Power	3	0.500000
Security	6	1.000000
Tradition	6	1.000000
Universalism	6	1.000000

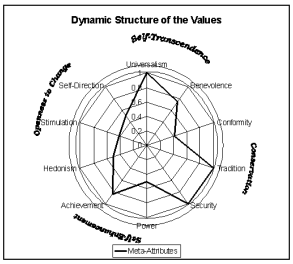

Figure 3. Juan Valdez's HVS graph in life-cycle 2

Using Eq. (2) to obtain the HVS of Juan Valdez, in this 2º cycle of his life, is had:
VS = 1.389867

The normalized value of the Values-scale of Juan Valdez, in this life-cycle is:

$$VS_n = \frac{VS}{VSm} = \frac{1.389867}{2.93} = 0.474357$$

Additionally, the recommender system calculates automatically the weight which in this case is 0.52.

According to this new values-scale, it is observed that Juan Valdez continues being a person with emphasis in the preoccupation for the well-being of others, he battles for stability and conservatism; therefore, due to the superiority of the value Tradition and Security, even though the meta-attributes Hedonism and Stimulation increase, the system of services and banking products would continue recommending that Juan Valdez use a bank with the same characteristics previously recommended.

Using the Coherence Eq. (4), and replacing the values corresponding to each life-cycle:

$$Coh_{C_1} = (0.342708, 0.43) \qquad Coh_{C_2} = (0.474357, 0.52)$$

According to the previous, in life-cycle 1 of Juan Valdez, his HVS is 0.342708 with 0.43 coherence and in life-cycle 2 his HVS is 0.474357 with 0.52 coherence, which means that the level of coherence between the actions of the user in the system and his preferences and interests of life-cycle 1 are little coherent, whereas in life-cycle 2 this coherence increases.

In accordance with this result, the recommendation system, based on HVS, can contribute to follow up on the changes in the HVS in different user life-cycles.

7. Conclusions and Future Work

In this paper, we have shown that the human values scale changes according to user life cycles. That is, when there is a change of cycle, the relevance given by the user to particular aspects of his/her life varies according to his/her experiences. Some examples are: change of ideas, cultural change and contextual change, among others.

The proposed methodology is useful to compute the Human Values Scale from a *Smart User Model*.

We have defined a Coherence function between the user actions and user preferences in a recommender system to build the user values-scale based on the emotional component of the Smart User Model, and the relevance that the user gives to the situations in every cycle of your life.

The preliminary results obtained from a case study in the banking domain show that Human Values Scale of the user is influenced in different life-cycles according to the emotional component of the SUM.

We are working on the implementation of our framework in order to provide the methodology with machine learning techniques to obtain better recommendations in several domains.

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