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PARTICIPATORY MODELLING OF THE CAUSAL RELATIONSHIP BETWEEN SELF-BELIEFS AND PERSONALITY USING AGGREGATED FUZZYRELATIONAL MAPMODEL AND KOSKO-HAMMING DISTANCE

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ABSTRACT. Fuzzy Relational Map is an efficient tool in establishing the causal relationship between two disjoint sets of concepts. In situations, wherein the data available is unsupervised involving emotions and reasons described in a language that is vague or difficult to interpret, Fuzzy Relational Map is the pertinent approach of choice. Personality is a psychological construct that has different traits and these traits have some unique behavioral beliefs underneath. In this paper, an extension of a fuzzy relational map called aggregatedFuzzyRelational Map is used to study the association between the traits of personality and the behavioral beliefs that influence a certain type of personality. Further, the fixed points are analyzed with the aid of Kosko-Hamming Distance.

1. INTRODUCTION

Carol Dweck in her research article titled "Can Personality be changed?" claims that core beliefs or belief systems that can organize and shape people's goals and strivings, along with their construals of and reactions to the environment, create consistent patterns of experience and actions [4]. These consistent pattern

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of experience and actions is identified and branded as personality in the society. Many prominent personality theorists of different opinions acknowledge that beliefs are a fundamental part of personality. Human beings develop beliefs and mental representations about life and world from their initial stages of development [11]. These personal beliefs have the power to define one's views about life and affect their behaviour, action and experience that solidifies into personality [15].

In this study, the aggregated fuzzy relational map model is espoused to study the causal influence of human behavioural beliefs on the personality type. The beliefs and traits of personality are two disjoint sets and there is a possibility of coming across fuzzinessand uncertainty while assessing one's personality type or understanding one's belief system. Hence, the FRM fuzzy model is adopted in studying the relationship between belifs and types of personality.

2. Fuzzy Relational Map - A fuzzy tool

Fuzzy relational maps are introduced by W.B. Vasantha Kandasamy [12]as fuzzy-graph structures to represent causal reasoning. They combine fuzzy logic and neural networks to represent the knowledge and reasoning of the experts with an ease [12]. Fuzzy Relational Map (FRM) is actually a generalisation of Fuzzy Cognitive Map (FCM) that can be used to analyse the causal influence between disjoint concepts. FRM is formed between to two fuzzy sets that are disjoint in nature.

An FRM is a bi-directed graph or a map from $D \to R$ with nodes or concepts from domain space (D) and range space (R) representing the elements of a system under consideration and directed connections or edges that establish causal relationships between the concepts [12]. The nodes and edges of fuzzy relational maps take values from [0,1] or[-1,1]. Theassociation between the concepts is given by the relational matrix $E = (e_{ij})$ where e_{ij} is the weight of the edge. Every edge D_iR_j (or R_jD_i) in the FRM is weighted with a number from[0,1] or [-1,1]. The weight of the edge gives us the idea on how do the nodes on the domain space influence the nodes on the range space.

$$e_{ij} = \begin{cases} -a_{ij}, & \text{increase (or decrease) } D_i \text{ implies decrease (or increase) in} R_j \\ 0, & \text{increase} D_i \text{does not have any effect on} R_j \\ +a_{ij}, & \text{increase} D_i \text{implies increase in} R_j \end{cases}$$

In this study the average aggregation method, suggested by Kosko [6] for aggregating a large number of FCMs is adopted. Suppose that there are n participants who assign a weight value w_{ij}, between the nodes D_i of domain space and R_j with the same number of concepts, then the aggregated weight between these nodes may be defined as the average value of the n weights,

$$w_{ij}^{(ave)} = \frac{1}{n}(w_{ij}^{(1)} + \ldots + w_{ij}^{(n)}).$$

Kosko-Hamming Distance [13] is a distance function similar to Hamming Distance that is useful in comparing the resultant state vectors that have some prior relation. Suppose two experts work on the same collection of attributes using the FRM model. Let E_1 and E_2 be the adjacency matrices of the two FRMs and $X = (a_1, a_2, \ldots\ldots, a_n) \in Z_2^n$ be the initial state vector. Let the resultant of X on E_1 and E_2 be Y_1 and Y_2. The Kosko-Hamming distance between them is denoted by $d_k(Y_1, Y_2)$. Using the Kosko-Hamming distance two resultant vectors that depend on some fixed initial state vector can be compared. By this comparison, it can be recognized that how far two experts have the same opinion or differ upon a given state vectorfor a particular concept which can be specially analysed to identify the cause of such variation.

3. Description of the Problem

Every individual is unique in their attitudes and behaviours and this makes them different and interesting. And surprisingly not all of them are made of a same flavour or fabric. Everyone is different and special in many different angles. From the way how one conducts oneself and relates with their environment, the society gives a name for their individuality[10]. The world labels every individual by their attitude, behaviour and values as a particular personality type. The recent researches confirm that the personality is the outcome of set of beliefs that an individual holds to be true [11-12]. This study aims at determining qualitatively the causal influence between personality traits and self-beliefs and examines the influence of the Big Five personality traits on self-beliefs or personal values.

The Big-5 factors theory of personality, known as 'OCEAN' model, is one of the widely accepted personality theories. This theory includes 5 main characteristics which may encompass some finer traits of personality [8-9]. Eric claims

that the Big Five is a reasonable representation of a minimum number of individual difference dimensions taken at the broadest and most abstract level of description [3]. A brief explanation on the factors of Big-5 model.

Openness: This includes being curious as opposed to conservative and cautious behaviour. It also includes a curiosity about adventure and appreciation for exploration. **Conscientiousness:** People with this trait would demonstrate self-discipline and plan out things, rather than being spontaneous. They are careful and diligent, organized and efficient versus easy-going and careless.

Extroversion: This trait displays how outgoing or reservedsomeone is.It also includes people displaying positive emotions, energy and so on.

Agreeableness: This trait is about how well people can cooperate with others in a friendly and compassionate or competitive.

Neuroticism: This trait includes how people deal with things such as depression, anger and unpleasant situations.The traits of Big-5 model of personality are taken as the nodes of the domain space.

P_1: Openness
P_2: Conscientiousness
P_3: Extraversion
P_4: Agreeableness
P_5: Neuroticism

Personality traits are partly developed by innate nurturing, socialization and education and are also formed by the beliefs held by an individual [5]. The widespread agreement as to what can facilitate the development of the critical personality traits is that beliefs do the work [4]. People's beliefs include their mental representations of nature and workings of the self, of their relationships, and of their world [4]. Thought it is not well articulated, it is a universally accepted fact that beliefs and values an individual assumes to be true in their environment are the sap of one's personality type [15]. In order to understand the personality type or to correct the pathological personality type, we need to understand the beliefs that play a vital role in the formulation of personality [12,15]. The core beliefs related to different domains such as survival, security, etc., are taken for this study.

B_1: Control
B_2: Future
B_3: Interpersonal

B_4: Intrapersonal
B_5: Life
B_6: Security
B_7: Survival
B_8: Value

4. Methodology and construction of FRM

A five-factor personality inventory, developed from the International Personality Item Pool (IPIP)[2], was employed as an online belief-statement form and was completed by around 40 participants. All the participants were of age group 17 to 20 years doing their graduation in different streams. This particular group of students are chosen because they go through a transition period of establishing their personality types as part of their identity formation [4,10,11]. The participants were asked fill in a teamil version of belief-personality questionnaire in google forms online. The participants were instructed to assign weights of relationships between the concepts on a scale of 1-10 for each link. Ten (10) denoted the highest value and one (1) the lowest. The strategy adopted in the study was to ask participants for self-reports of the degree of truth of the personal beliefs that are linked to one or more of the Five Factor dimensions. Correlations between the self-beliefs and the relevant dimensions is taken as the weight of the causal relationship between them. The participants were divided into two groups each consisting of equal number members. One group was all male participants while the other is all female participants. The experts identified 8 broad domains of beliefs and the matching traits of personality.The values were aggregated and additively superimposed using the average aggregation method. This Expert-based FRM model shown below (Fig1) is derived from the aggregation processes, to help this study realize its objectives.

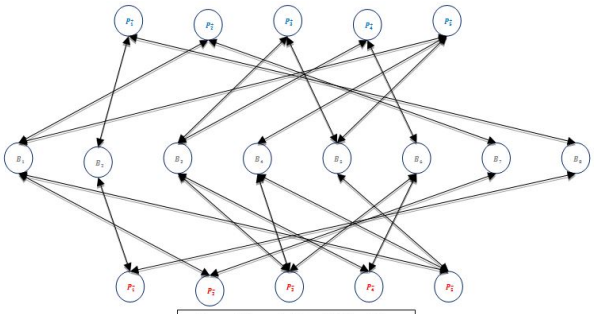

Figure 1: Aggregated Fuzzy Relational Map

5. Analysis of the Problem Using Aggregated FRM

Having said that there is a strong association between the beliefs and traits of personality of an individual, we attempt to explore further into it using the aggregated FRM tool. The aggregated FRM of a male group of students and female group of stuents and their respective relational matrices are obtained using average aggregation operation. E_1 and E_2 are taken to be the aggregated relational matrices of the opinon of the male and female participants respectively.

	P1+	P1-	P2+	P2-	P3+	P3-	P4+	P4-	P5+	P4-
B1	0	0	0.62	0.61	0	0	0	0	0.61	0.42
B2	0.79	0.42	0	0	0	0	0	0	0	0
B3	0	0	0	0	0.69	0.46	0.85	0.34	0	0
B4	0	0	0	0	0	0.64	0	0	0.51	0.85
B5	0	0	0.7	0	0.63	0	0	0	0.34	0.79
B6	0	0	0	0	0	0.46	0.77	0.38	0	0
B7	0	0	0.76	0.59	0	0	0	0	0	0
B8	0.68	0.32	0	0	0	0	0	0	0	0

E_1: Aggregated relational matrix of the opinion of the male participants

	P1+	P1-	P2+	P2-	P3+	P3-	P4+	P4-	P5+	P5-
B1	0	0	0.65	0.45	0	0	0	0	0.46	0.56
B2	0.76	0.42	0	0	0	0	0	0	0	0
B3	0	0	0	0	0.66	0.39	0.85	0.26	0	0
B4	0	0	0	0	0	0.70	0	0	0.42	0.71
B5	0	0	0.73	0	0.80	0	0	0	0.26	0.77
B6	0	0	0	0	0	0.28	0.66	0.37	0	0
B7	0	0	0.81	0.45	0	0	0	0	0	0
B8	0.75	0.33	0	0	0	0	0	0	0	0

E_2: Aggregated relational matrix of the opinion of the female participants

6. Method of determining the Hidden pattern [12]

Suppose that the dynamical system $E_1$is started by switching on a node in the domain space say,$A_1 = (1, 0, 0, \ldots, 0)$. Let E_1 be the associated adjacency reltional matrix. To find the hidden pattern the input vector is passed through the dynamic system. This is done by the usual matrix multiplication $A_1^{\circ}E_1$and

$A_1^{\circ}(E_1)^T$ in case E_1 is a rectangular matrix. The resultant vector is updated and thresholded by taking the threshold value to be equal to $\alpha = 0.75$. If the FRM settles down with a unique state vector repeating in the manner $X_1 \to X_2 \to \ldots \to X_i \to X_n$, then this equilibrium state is called a limit cycle of the FRM. The unique state vector which is the equilibrium state of a dynamical system is called a fixed point. The same process is repeated for the second dynamical system E_2 and the fixed points are obtained.

7. Results and Discussion

The input vectors with ON state of the nodes $P_1^+, P_1^-, \ldots, P_5^+, P_5^-$ are passed through the dynamical systems E_1 and $E_2$and the corresponding fixed points are calculated. The hidden pattern of the two dynamcical systems are compared using Kosko-Hamming distance function and tabulated as follows.

Node	Fixed point of E_1	Fixed point of E_2	$d_K(E_1, E_2)$
1	{(0 1 0 0 0 0 0 1), (1 1 0 0 0 0 0 0 0 0)}	{(0 1 0 0 0 0 0 1), (1 1 0 0 0 0 0 0 0 0)}	(0, 0)
2	{(0 1 0 0 0 0 0 1), (1 1 0 0 0 0 0 0 0 0)}	{(0 1 0 0 0 0 0 1), (1 1 0 0 0 0 0 0 0 0)}	(0, 0)
3	{(1 0 0 1 1 0 1 0), (0 0 1 1 0 0 0 0 1 1)}	{(1 0 0 0 1 0 1 0), (0 0 1 1 1 0 0 0 0 1)}	(1, 2)
4	{(1 0 0 0 0 0 1 0), (0 0 1 1 0 0 0 0 0 0)}	{(1 0 0 0 0 0 1 0), (0 0 1 1 0 0 0 0 0 0)}	(0, 0)
5	{(1 0 1 1 1 1 1 0), (0 0 1 1 1 1 1 0 1 1)}	{(0 0 1 0 1 0 0 0), (0 0 0 0 1 0 1 0 0 1)}	(4, 4)
6	{(1 0 1 1 1 1 1 0), (0 0 1 1 1 1 1 0 1 1)}	{(0 0 1 0 0 1 0 0), (0 0 0 0 0 1 1 0 0 0)}	(4, 5)
7	{(0 0 1 0 0 1 0 0), (0 0 0 0 0 1 1 0 0 0)}	{(0 0 1 0 0 0 0 0), (0 0 0 0 0 0 1 0 0 0)}	(1, 1)
8	{(1 0 1 1 1 1 1 0), (0 0 0 0 0 1 1 1 0 0)}	{(0 0 1 0 0 1 0 0), (0 0 0 0 0 0 1 1 0 0)}	(0, 1)
9	{(1 0 0 1 1 0 1 0), (0 0 1 1 0 0 0 0 1 1)}	{(1 0 0 1 1 0 1 0), (0 0 1 1 1 0 0 0 1 1)}	(0, 1)
10	{(1 0 0 1 1 0 1 0), (0 0 1 1 0 0 0 0 1 1)}	{(1 0 1 0 1 0 1 0), (0 0 1 1 1 0 1 0 0 1)}	(2, 3)

The fixed points obtained imply that turning ON the traits in the input vector results in different resultant vectors turning ON different traits and the corresponding beliefs. The major observation is that the trait openness seems to be understood as being completely different from other traits. Also this trait turns ON the beliefs corresponding to the domains Futre (B_2) and Value (B_8) alone. This suggests that people who are open to new ideas are dreamers and they

value life. The trait conscientiousness is concerned with the beliefs pertaining to the domains Control (B_1) and Security (B_7). This implies that people who are scrupulously conscientious and careful in their approach might act out of insecurity andfear of not being in control. The ON state of the traits extraversion, agreeableness and neuroticism activate all the belief domains except Futre (B_2) and Value (B_8). This indicates that people who are concerned about living in harmony with others take care of beliefs that involves others.

Further from the calculation of Kosko-Hamming Distace, it is inferred that there is a distinct difference in the understanding and approval of personality types between male and female. The Kosko-Hamming distance$d_K(E_1, E_2) \geq 4$ in case of the personality type Extraversion which the highest of all. This hints at men and women having different opinion about their behaviour and characteristics pertaining to this personality type. The experts suggests that this may be due to the cultural difference that is dominant among the communities. Similarly female participants seem to have different opinions about the traits agreeableness and neuroticism also which would involve others.

8. Conclusion

Every individual possesses certain distinct personality characteristics which define their behaviours or actions. These implicit traits play an important role in driving an individual live a life that defines one's purpose and existence. According to the experts' opinion both the positive and negative core beliefs are present in all types of personality and have the same kind of consequence. Strengthening of the positive or rational beliefs weakening the irrational beliefs strengthen a particular type of the personality that is desirable. In order to strengthen a particular belief one needs to revisit it again and again. Revisinting the rational beliefs clarifies one's mental representation, strengthens the neural connection and hence reinforces a particular personality style. The different combinations of core beliefs could further display themselves as compound beliefs or creating different shades of the personality spectrum.

This studyinfers that the positive core beliefs have a dominance over the negative core beliefs. The presence of positive core beliefs suppresses the effect of negative core beliefs and consequently the influence on the personality. The negative side of the personality types discussed here have their own pits and

falls besides the benefits of their positive side in many different ways, but this study confirms that the positive core beliefs act as a bridle in overwhelming situations wherein one may lose control over oneself. The positive core beliefs strongly anchor the personality to hold onto one's values and virtues that may define their personality.

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