

Ören, T.I. and Ghasem-Aghae, N. (2003). Personality Representation Processable in Fuzzy Logic for Human Behavior Simulation, Proceedings of the 2003 Summer Computer Simulation Conference, Montreal, PQ, Canada, July 20-24, 2003, pp. 11-18.

Personality Representation Processable in Fuzzy Logic for Human Behavior Simulation

Tuncer I. Ören
Ottawa Center of the McLeod Institute
of Simulation Sciences [OC-MISS]
SITE, University of Ottawa, Ottawa, ON, Canada
oren@site.uottawa.ca

Nasser Ghasem-Aghaee
Visiting Professor at the OC-MISS
Department of Computer Engineering
University of Isfahan, Isfahan, Iran
aghaee@eng.ui.ac.ir

“We often fail to realize how little we know about a thing until we attempt to simulate it on a computer”
[Donald Knuth, 1968]

Keywords: Personality knowledge

Abstract

The state-of-the art of psychological knowledge about the personality types is distilled to provide a basis for the specification of fuzzy agents with dynamic personality for the simulation of human behavior. The thirty facets, clustered in five traits (or, factors) to determine the personality types are outlined. Three concise representations of the primary characteristics of human personality are presented; they are: personality template, personality vector, and personality charts. In an accompanying article [Ghasem-Aghaee and Ören, 2003], the first two of these representations provide the basis for using fuzzy logic to process qualitative (or linguistic) personality variables.

1. INTRODUCTION

In memoryless systems, the output of the system at any point in time depends only on the value of the input at this time. In systems with state variables, a given input may induce different outputs depending on the value of the state variable. In systems with personality, the personality also influences the behavior of the system.

Simulation of human behavior has been an interesting and important area of research and application for a long time [Dutton and Starbuck, 1971; Cohn, 1989]. An extensive and systematic bibliography of the early studies is also provided in Dutton and Starbuck [1971]. Currently, simulation of human behavior has gained the focus of attention for several applications such as representing human behavior in military simulation [Pew and Mavor, 1998] and Web-based simulation of agent behavior [Campos and Hill, 1998]. The concept of infohabitants enlarges the domain of application of human behavior simulation to a more general area, i.e., simulation of intelligent entities. “Infohabitants of the

connected information systems include individuals, organizations, smart appliances, smart buildings, and other smart systems, as well as virtual entities acting on their behalf [Ören, 2002].

Personality knowledge is often expressed in terms of linguistic variables that can describe concepts that usually have vague and fuzzy values [Durkin, 1994]. Two excellent references for personality knowledge are Costa and McCrae [1992] and Acton [2001]. They present a five-factor model, referred to also as the OCEAN model and an extensive table outlining the research on personality by over thirty researchers. Other good references on the topic are Howard [2000] and Howard and Howard [2001a, b]. They refer to the five-factor model as the Big Five.

Agents are used for the simulation of human behavior. Martinez-Miranda and Aldea [2002] describe an agent model that simulates the human behavior in a team. Urban and Schmidt [2001] present PECS reference model for the construction of human-like agents. Fuzzy agents are used for the simulation of human behavior: Adamatti and Bazzan [2002] and Bazzan and Bordini [2001] describe the development of a framework for simulation of agents with emotions. El-Nasr and Skubic [1998] provide a fuzzy emotional agent for decision-making in a mobile robot. The model deals with three negative emotions: fear, pain and anger. El-Nasr et al. [2000] propose a new computational model of emotions that can be incorporated into intelligent agents and other complex, interactive programs. The model uses a fuzzy-logic representation to map events and observations to emotional states. Michaud [1997] presents a control architecture for dynamic selection of behaviors that when using fuzzy logic, allows behaviors to be efficiently selected by different sources. Mitaim and Kosko [1998] present neural fuzzy agents for profile learning and adaptive object matching.

In another article, fuzzy agents with dynamic personality are promoted for the simulation of human behavior and fuzzy

logic is used to process qualitative variables to represent personality knowledge [Ghasem-Aghaee and Ören, 2003]. The aims in this article are (1) to develop a *concise and flexible representation of personality knowledge* based on the state-of-the-art of *personality theories* processable in fuzzy logic and which could be a basis for the specification of software *agents with personality*; and (2) to have the ability of represent *personality dynamics*.

The rationale for these aims is to provide a solid theoretical background for the simulation of human behavior as well as other infohabitants. When distilling the personality knowledge for simulation purposes, the observations of Knuth [1968] becomes very relevant. However, the temptation to develop knowledge independent of the knowledge provided by personality theories is not considered in this article. The fuzzy logic is very natural way to process qualitative (or linguistic) variables associated with personality knowledge. The aim 2 is to have the ability of representing the modifications of a personality over time.

2. PERSONALITY

A concise taxonomy of taxonomies of personalities is given at the site of personality project (Personality Project). In contemporary psychology, personality is specified as a function of thirty attributes –each of which called personality facet. The personality facets are clustered in five groups –each called a personality trait [or personality factor]. The five personality factors are also referred to as “the big five” [Costa and McCrae, 1992; Howard, 2000]. The value of each personality factor is determined by the values of its six facets. The five clusters of personality factors are also referred to by letter designation [Acton, 2001; Howard and Howard, 2001a, b]. Acton refers to them as the OCEAN model.

In the OCEAN model, the letters stands for the following meanings:

- O: Openness, culture, originality, or intellect
- C: Conscientiousness, consolidation, or will to achieve
- E: Extraversion
- A: Agreeableness or accommodation
- N: Need for stability, negative emotionality, or neuroticism

In the sequel, Tables 1-5 are adopted from Howard [2000], Howard and Howard [2001a, b] and from Costa and McCrae [1992].

3. PERSONALITY TRAITS

3.1 Openness:

“Openness to Experience is tendency to be intellectual, interested in the arts, emotionally aware, and liberal.” [Acton-glossary]. “Openness refers the number of interests to which one is attracted and the depth to which those interests are pursued. It is also referred to as culture, originality, or intellect. It is about creativity.” [Howard and Howard, 2001a]. The values of the personality facets can be specified at several levels. In Table 1a, three levels are mentioned, i.e. low, medium, and high. It could be some other number of levels such as five levels (very low, low, medium, high, very high) or seven levels (extremely low, very low, low, medium, high, very high, extremely high). The values of the linguistic variables representing the six facets of openness are given Table 1. (More than one value represents synonyms.) Openness is low when all six facets are low. It is medium or high if all six facets are medium or high, respectively. When the facets are not all equal, the dominant one determines the personality type. Depending the three levels [i.e. low, medium, or high] of the openness, three types of personalities are identified: a preserver, moderate, and explorer.

However, even with only three values for each of the six facets the total number of possible combinations is 729 ($=3^6$). There is a need to find a way to represent the continuum of openness. Figure 1 represents the continuum of openness where a person may be 0.30 preserver (and 0.70 explorer). The expression of the linguistic variables in terms of numerical terms is explained by Ghasem-Aghaee and Ören [2003].

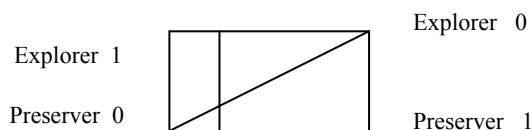


Figure 1. Continuum of openness

Each facet has a weight factor. In the determination of the overall value of a trait, the weighted value of each facet is computed by multiplying its measured value by the weight factor. The dominant facet determines the value of the trait.

3.2 Conscientiousness:

“Conscientiousness is tendency to set high goals, to accomplish work successfully, and to behave dutifully and morally” [Acton-glossary]. Furthermore, “conscience is the awareness of a moral or ethical aspect to one’s conduct together with the urge to prefer right over wrong” [AHD]. (See Table 2.)

3.3 Extraversion

“Extraversion is trait associated with sociability and positive affect.” [Acton-glossary]. “It refers to the number of relationships with which one is comfortable” [Howard and Howard, 2001a]. “Because the distribution of factor scores is normal and not bimodal, the practice of dichotomizing respondents for example, into extraverts and introverts, is unjustified. McCrae and Costa [1992] prefer speaking of *degree* of extraversion. For convenience’s sake, they speak of three level [low, medium, high] in which one might score – extraversion, ambiversion, and introversion” [Howard and Howard, 2001a, p. 10]. (See Table 3.)

3.4 Agreeableness:

“Agreeableness is tendency to be a nice person” [Acton-glossary]. It is also referred to as accommodation. (See Table 4.)

3.5 Negative emotionality

Negative Emotionality, neuroticism, or need for stability is the trait associated with emotional instability and negative affect [Acton-glossary]. “Negative Emotionality refers to the number and strength of stimuli required to elicit negative emotions in a person“ [Howard and Howard, 2001a]. (See Table 5.)

Table 1. Personality descriptors based on the levels [or values] of the six facets of **openness** and corresponding personality types and characteristics

Facets of openness	Levels		
	low	medium	high
Fantasy	focuses on here and now	occasionally imaginative	Imaginative, daydreams
Aesthetics	uninterested in art	moderate interest in art	appreciates art and beauty
Feelings	ignores and discounts feelings	accepts feelings	values all emotions
Actions	prefers the familiar	a mixture of preference of the familiar and the new	prefers variety, tries new things
Ideas	narrower intellectual focus	moderate curiosity	broad intellectual curiosity
Values	Dogmatic, conservative	moderate	open to new values open to reexamining values

Personality type	Preserver	Moderate	Explorer
Personality characteristics	<ul style="list-style-type: none"> - Has narrower interests - Is more comfortable with the familiar - Is perceived as more <ul style="list-style-type: none"> -- conventional -- conservative - Is perceived not as <ul style="list-style-type: none"> -- more authoritarian 	<ul style="list-style-type: none"> - Can explore the novel with interest when necessary [but too much would be tiresome] - Can focus on the familiar for extended periods of time [but would develop a hunger for novelty] 	<ul style="list-style-type: none"> - Has broader interests - Has a fascination with novelty and innovation - Would generally be perceived as liberal - Reports more introspection and reflection
Social roles	applied scientists financial managers performers project managers		Architects, artists, change agents Entrepreneurs, theoretical scientists [social and physical]

Table 2. Personality descriptors based on the levels [or values] of the six facets of **conscientiousness** and corresponding personality types and characteristics

Facets of conscientiousness	Levels		
	low	medium	high
Competence	often feels unprepared	sometimes feels prepared	feels capable and effective
Order	Unorganized unmethodical	half-organized	well-organized, neat, tidy
Dutifulness	casual about obligations	covers priorities	governed by conscience, reliable
Achievement striving	low need for achievement	serious about success	driven to achieve success
Self-discipline	procrastinates distracted	mix of work and play	focuses on completing tasks
Deliberation	Spontaneous, hasty decisions	thoughtful	thinks carefully before acting

Personality type	Flexible	Balanced	Focused
Personality characteristics	Easily distracted Less of their total work effort is goal-directed Less focused on goals More hedonistic Weak control over their impulses	Can easily move: - from focus to laxity - from production to research	High self-control Consistent focus on personal and occupational goals In the extreme it results in workaholism. Difficult to distract
Social roles	Consultants, detectives, researchers	manager	Executives, high achievers, leaders

Table 3. Personality descriptors based on the levels [or values] of the six facets of **extraversion** and corresponding personality types and characteristics

Facets of extraversion	Levels		
	low	medium	high
Warmth	Reserved, formal	attentive	Affectionate, friendly, intimate
Gregariousness	prefers to be alone	alone/others	Gregarious, prefers company
Assertiveness	stays in background	in foreground	Assertive, speaks up, leads
Activity	leisurely pace	average pace	vigorous pace
Excitement-seeking	low need for thrills	occasional need for thrills	craves thrills
Positive Emotions	seldom exuberant	moderate exuberance	usually cheerful

Personality type	Introvert	Ambivert	Extravert
Personality characteristics	Tends to be: - independent - reserved - steady - comfortable with being alone	Able to move: - from outgoing social situations - to the isolation of working alone	Tends to: - exert leadership - be active [physically and verbally] - be more friendly and outgoing
Social roles	production managers scientists [physical and natural sciences]	player-coach	arts politics sales social sciences

Table 4. Personality descriptors based on the levels [or values] of the six facets of **agreeableness** and corresponding personality types and characteristics

Facets of agreeableness	Levels of agreeableness		
	low	medium	high
Trust	Cynical, skeptical	cautious	see others as honest & well-intentioned
Straightforwardness	Guarded, stretches truth	tactful	Straightforward, frank
Altruism	reluctant to get involved	sometimes willing to help others	willing to help others
Compliance	Aggressive, competitive	approachable	yields under conflict, defers
Modesty	feels superior to others	equal	self-effacing, humble
Tender-Mindedness	Hardheaded, rational	responsive	tender-minded, easily moved

Personality type	Challenger	Negotiator	Adapter
Personality characteristics	- Egocentrism [independence] - Focused on his or her personal norms and needs rather than on those of the group - Concerned with	- Situationalism [interdependence] - is able to move from leadership to followership as the situation demands	- Altruism [dependence] - Is prone to accept the group's norms rather than insisting on his or her personal norms - Harmony is more important than broadcasting one's personal notion of truth

	acquiring and exercising power - Moves against people - Tough-minded - In the extreme becomes: -- narcissistic -- antisocial -- authoritarian -- paranoid personality		- Moves toward people - Tender-minded - In the extreme becomes dependent personality who has lost his or her sense of self
Social roles	Advertising, managing, military leadership		Psychology, social work, teaching

Table 5. Personality descriptors based on the levels [or values] of the six facets of **negative emotionality** and corresponding personality types and characteristics

Facets of negative emotionality	Levels		
	low	medium	high
Worry [anxiety]	Calm, relaxed	worried-calm	Worried, uneasy
Anger	slow to anger, composed	some anger	quick to feel anger
Discouragement [depression]	rarely discouraged	occasionally discouraged	easily discouraged
Self-consciousness	seldom embarrassed	sometimes embarrassed	easily embarrassed
Impulsiveness	resists urges easily	sometimes tempted	easily tempted
Vulnerability	handles stress easily	some stress	difficulty coping stress

Personality type	Resilient	Responsive	Reactive
Personality characteristics	Rational, impervious	Not typically able: - to maintain the calmness of a resilient for as long a period of time - to maintain the nervous edge of alertness of a reactive	- Susceptibility to negative emotions and discontent with life - At higher intellectual and academic levels, extreme reactivity interferes with performance
Social roles	air traffic controllers, airline pilots, engineers, finance managers, military snipers	stock trader	Academics, customer service professionals, social scientists

4. FLEXIBLE REPRESENTATIONS OF PERSONALITY

In representing personalities, one has to consider primary as well as compound characteristics. Primary characteristics are related with the personality facets and traits. Some of the existing ways to represent personality characteristics are string notation (such as N+E-O=A=C=), tabular representation [Howard and Howard, 2001a] and radial representation [Howard and Howard, 2001b].

4.1 Primary Characteristics

Personality traits are determined (symbolically or numerically), from the values of the personality facets. Hence the values can be symbolic, such as -, =, +; or qualitative such as low, medium, high; or linguistic such as calm, relaxed, worried-calm, worried, uneasy. When the values are numerical, they can be normalized to have a

value between 0.00 and 1.00 or between 0 and 100. Three types of representation of a personality are explored: personality template, personality vector, and personality chart. The linguistic values such as calm, relaxed, worried-calm, worried, or uneasy can also be entered corresponding to the levels specified as low, medium, high; or -, =, or +.

4.1.1 Personality Template

Personality template (Table 6) is adopted from [Howard and Howard, 2001a]. It contains the thirty facets of personality traits grouped under the corresponding five personality traits. There is also a column to indicate the weight of each facet determined by factor analysis (w). Facets are linguistic variables; their symbolic qualitative values (sv) and numerical values (nv) can be stored in the corresponding slots. The value can be qualitative (such as low, medium, high) or quantitative (such as 0.00, 0.50, 1.00; or a number

n: $0 \leq n \leq 100$). For convenience, qualitative values can be represented by symbols such as:

- low A score below 45
 - = medium A score between 45 and 55
 - + high A score above 55
- or
- very low
 - low
 - = medium
 - + high
 - ++ very high

In a computer-aided system, it is possible to avoid inconsistencies; an interface may assist users to select the values consistent with the values as given in Tables 1-5. As a variant of the personality template one can have an additional column to graphically represent the values of the facets.

Table 6. Personality template

	personality facets	w	sv	nv	descriptors
O1	Fantasy				
O2	Aesthetics				
O3	Feelings				
O4	Actions				
O5	Ideas				
O6	Values				
C1	Competence				
C2	Order				
C3	Dutifulness				
C4	Achievement striving				
C5	Self-discipline				
C6	Deliberation				
E1	Warmth				
E2	Gregariousness				
E3	Assertiveness				
E4	Activity				
E5	Excitement seeking				
E6	Positive emotions				
A1	Trust				
A2	Straightforwardness				
A3	Altruism				
A4	Compliance				
A5	Modesty				
A6	Tender mindedness				
N1	Worry				
N2	Anger				
N3	Discouragement				
N4	Self consciousness				
N5	Impulsiveness				
N6	Vulnerability				

4.1.2 Personality Vector

There are straightforward ways to represent variables with large variabilities. For examples color can unequivocally be represented with three values, i.e. R(ed), G(reen), and B(lue) as shown in Figure 2. Similarly, a vector can be defined to represent personalities. The elements of a personality vector

are shown in Figure 3. Once, the values of the six facets of a personality trait are specified, in the personality template, the corresponding personality type can be determined and entered in the personality vector. to concisely represent a personality [Ghasem-Aghaee and Ören, 2003].

R[ed]	255
G[reen]	255
B[lue]	170

Figure 2. Vector representation of a color

	Personality traits	sv	nv	personality type
O	Openness			
C	Conscientiousness			
E	Extraversion			
A	Agreeableness			
N	Negative emotion			

Figure 3. Personality vector

Figure 4 is an example of a vector representation of a personality.

	Personality traits	sv	nv	personality type
O	Openness	+		explorer
C	Conscientiousness	+		focused
E	Extraversion	=		ambivert
A	Agreeableness	=		negotiator
N	Negative emotion	+		reactive

Figure 4. Vector representation of an (explorer, focused, ambivert, negotiator, and reactive) personality

4.1.3 Personality Charts

A personality chart is a Kiviat chart (or a web chart) (Figure 5). The number of axes is equal to five (which is the current perception of the number of personality traits). Each axis represents a personality trait and the values are normalized between “0” and “1.0” The value “0” is at the center and corresponds to the value “low.” The value “1.0” is at the outer edge and corresponds to the value “high.” Figure 5 also depicts the personality specified in Figure 4. A variant of the personality chart (to be called possibly, facet chart) can have, for each trait, six additional rays –between two principal rays representing personality traits– to represent the corresponding weighted values of the facets. Facet charts can ease the perception of the relationship of the values of each trait and corresponding facets. Especially, when intervention to modify a trait is in question, one can easily see which facet(s) one has to work with.

4.2 Compound Characteristics

The vector representation of some examples of compound personality types are given in Figures 6-9. Figure 6 shows

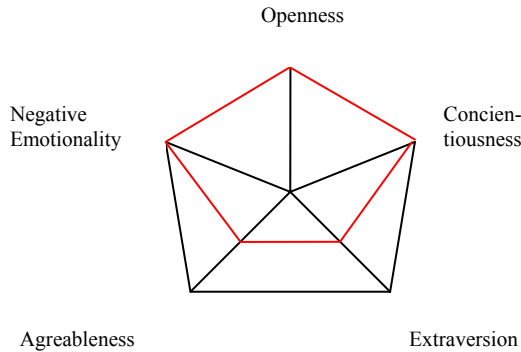


Figure 5. A personality chart representation of the personality specified in Figure 4.

the personality traits for problem solving styles. The symmetry of the influence of the primary characteristics can easily be seen. For example, an implementor is a preserver and a focused person. Figure 7-9 outline the compound personality characteristics for learning, leadership, and conflict styles, respectively. “A theme, as we use the term, is a trait which is attributable to the combined effect of two or more separate traits. Because the most recent version of the Costa and McCrae’s full facet test (the *NEO-PI-R*) has only been available for a couple of years, the identification of themes using their thirty-facet/five-factor terminology is only just beginning to surface. Five years from now, many more themes will be reported in the research literature” [Howard and Howard, 2001a].

	Problem solving style			
	generator	implementor	conceptualizer	optimizer
O[penness]	- preserver	- preserver	+ explorer	+ explorer
C[onscientiousness]	- flexible	+ focused	- flexible	+ focused
E[xtraversion]				
A[greableness]				
N[egative emotion]				

Figure 6. Vector representation of personalities for different problem solving style

	Learning style			
	classroom	tutorial	correspondence	independent
O[penness]				
C[onscientiousness]				
E[xtraversion]	- introvert	+ extravert	- introvert	+ extravert
A[greableness]				
N[egative emotion]	+ reactive	+ reactive	- resilient	- resilient

Figure 7. Vector representation of personalities for different learning style

	Leadership style			
	trouble-shooter	traditionalist	visionary	catalyst
O[penness]	- preserver	- preserver	+ explorer	+ explorer
C[onscientiousness]	- flexible	+ focused		
E[xtraversion]				
A[greableness]			- challenger	+ adaptor
N[egative emotion]				

Figure 8. Vector representation of personalities for different leadership style

	Conflict style			
	negotiator	aggressor	submissive	avoider
O[penness]				
C[onscientiousness]	= balanced	+ focused	- flexible	- flexible
E[xtraversion]	=+ ambivert/extrovert	+ extrovert	- introvert	- introvert
A[greableness]	= negotiator	- challenger	+ adaptor	
N[egative emotion]	= responsive	+ reactive	- resilient	+ reactive

Figure 9. Vector representation of personalities for different conflict style

5. DYNAMICS OF PERSONALITY:

The values of the personality facets may be modified according to the desired personality traits [Howard, 2000,

pp. 756-761]. The change of the personality traits by age are also explained by Howard [2000, p. 439]. After updating the values of the facets one can reassess the personality of an

individual and a new personality template and associated personality vector can represent the new personality. More knowledge about the mechanisms to influence each personality facet may be used to decrease the granularity of the five-factor model. For example, anger –a facet of the negative emotionality– is caused when expectancies are not met; and one becomes angry to those that one perceives as responsible (including self). To lower anger, one can lower or modify personal expectancies or one may choose to be tolerant or forgiving. Of course, these may require a mature and appreciative disposition of the unacceptable behavior of others.

6. CONCLUSIONS:

The state-of-the-art of the personality theories and applications are reviewed and outlined and pointers to important sources are given. The article by Ghasem-Aghaee and Ören [2003] uses fuzzy logic concepts to process personality knowledge representations used in this article. Furthermore, it provides the basis for the specification of fuzzy software agents with dynamic personality. In simulation of intelligent entities, understanding and representing of both static and dynamic knowledge about personality is paramount. This article bridges the psychological knowledge about personality and modeling and simulation. Hence may facilitate the validation of the model to represent personality knowledge in a simulation study. Harmon et al. [2002] provide additional knowledge on the validation of human behavior representation.

ACKNOWLEDGMENT

This article and several other publications are based on the research done by the authors while the senior author was hosting his colleague during his sabbatical leave from the University of Isfahan, Iran.

REFERENCES

- Acton, G.S. (2001). Five-Factor Model: <http://www.personalityresearch.org/>
- Acton-Glossary: <http://www.personalityresearch.org/glossary.html>
- Adamatti, D.F., Bazzan, A.L. (2002). A Framework for Simulation of Agents with Emotions, <http://www.inf.ufbrs.br/~adamatti/pag/ingles/Workcomp02.pdf>
- [AHD] The American Heritage Dictionary: <http://www.bartleby.com/61/86/C0578600.html>
- Bazzan, A.L.C., Bordini, R.H. (2001). A Framework for the Simulation of Agents with Emotions, <http://www.inf.ufbrs.br/~adamatti/pag/ingles/principalingles.htm>
- Campos, A.M.C., Hill, D.R.C. (1998). Web-based Simulation of Agent Behaviours. 1st International Conference on Web-based Modeling and Simulation (P. Fishwick, D.R.C. Hill, and R. Smith (eds.)), SCS, San Diego, CA, pp. 9-14.
- Cohn, A. (ed.) (1989). Proceedings of the 7th Conference of the Society for the Study of Artificial Intelligence and Simulation of Behaviour. Pitman, London, UK; Morgan Kaufmann, San Mateo, CA.
- Costa, P.T., Jr., McCrae, R.R. (1992). NEO PI-R Professional Manual, Odessa, Fla: Psychological Assessment Resources, <http://psyche.tvu.ac.uk/phdrg/atkins/atws/person/67.html>
- Durkin, J. (1994). Expert Systems – Design and Development, Prentice-Hall (McMillan Publishing Co.) Englewood Cliffs, NJ.
- Dutton, J.M., Starbuck, W.H. (1971). Computer Simulation of Human Behavior. John Wiley, New York, NY.
- El-Nasr, M.S., Skubic, M. (1998). A Fuzzy Emotional Agent for Decision-Making in a Mobile Robot, www.cecs.missouri.edu/~skubic/Papers/fuzzieee.pdf
- El-Nasr M.S., Yen, J., Ioerger, T.R. (2000). “FLAME-Fuzzy logic Adaptive Model of Emotions” Autonomous Agents and Multi-Agent Systems, 2000 Kluwer Academic Publishers Netherlands, 3, 219-257.
- Ghasem-Aghaee, N., Ören, T.I. (2003). Towards Fuzzy Agents with Dynamic Personality for Human Behavior Simulation, In Proc. of the 2003 Summer Simulation Conference, Montreal, PQ, Canada.
- Harmon, S.Y., Hoffman, C.W.D., Gonzalez, A.J., Knauf, R., Barr, V.B. (2002). Validation of Human behavior representations, http://www.msiac.dmsoc.mil/vva/Special_Topics/HBR-Validation/hbr-validation-pr.pdf
- Howard, P.J. (2000). The Owner’s Manual for the Brain, Second Edition, Bard Press, Atlanta, GA, www.bradpress.com
- Howard, P.J., Howard, J.M. (2001a). The BIG FIVE Quickstart: An Introduction to the Five-factor Model of Personality for Human Resource Professionals, Center for Applied Cognitive Studies [CentACS], Charlotte, North Carolina, www.centacs.com/quickstart.htm
- Howard, P.J., Howard, J.M. (2001b). Owners Manual for the Personality at Work, Bard Press, <http://www.bardpress.com/personalityvata.htm>
- Knuth, D. (1968). The Art of Computer Programming, vol. 1 – Fundamental Algorithms, Addison-Wesley, Reading, MA.
- Martinez-Miranda J., Aldea, A. (2002) “A Social Agent Model to Simulate Human Behavior in Teamwork,” 3rd Workshop on Agent-Based Simulation, Passau, Germany.
- Michaud, F. (1997). Selecting Behaviors using Fuzzy Logic <http://www.gel.usherb.ca/michaudf/papers/FUZZ97.pdf>
- Mitaim, S., Kosko, B. [1998]. Neural Fuzzy Agents for Profile Learning and Adaptive Object Matching, Presence, 7:6, Dec. 1998, 617-637.
- Ören, T.I. (2002). Ethics as a Basis for Sustainable Behavior for Humans and Software Agents. Acta Systemica, 2:1, 1-5. (Presented at the 14th International Conference on Systems Research, Informatics and Cybernetics of the IIAS, July 29 - August 3, 2002, Baden-Baden, Germany)
- Personality Project – Taxonomies of Individual Differences: <http://pmc.psych.nwu.edu/perproj/readings-taxonomies.html>
- Pew, W., Mavor, A.S. [1998]. Modeling Human and Organizational Behavior – Applications to Military Simulations. National Academy Press, Washington, DC.
- Urban, C., Schmidt, B. (2001). PECS Agent-Based Modelling of Human Behaviour. In Emotional and Intelligent – The Tangled Knot of Social Cognition, AAAI Fall Symposium Series, North Falmouth, MA. www.or.uni-passau.de/5/publik/urban/CUrban01.pdf