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Effects of Cognitive Complexity in Agent Simulation: Fuzzy Rules and an Implementation

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1. Aims: 1/2

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
2. to have the ability of represent personality dynamics

1. Aims: 2/2

3. Role of cognitive complexity of individuals in problem solving (coping with complexity)
4. As a personality trait, *openness* is related with cognitive complexity
5. Hence, dynamic updates of openness corresponding to the changes in its facets can be used to update the values of cognitive complexity which in turn can affect the decision making abilities of the agents used in simulation.

Plan

1. Fuzzy logic and fuzzy sets
2. Fuzzy personality knowledge
3. Definitions: Agents
4. Fuzzy agents with dynamic personality
5. Openness is related with cognitive complexity
6. An implementation
7. Conclusions

1. Fuzzy Logic and Fuzzy sets

- Fuzzy logic developed by Lotfi Zadeh (1965).
- Zadeh suggests that it is possible to understand a statement as being 0.75 true or 0.50 true.
- He modified conventional set theory in which an individual could have a degree of membership which ranged over a continuum of values, rather than being either 0 or 1.

Linguistic variables:

- Introduced by Zadeh (1973).
- It describes some concepts, that usually have vague or fuzzy values.
- We are not restricted to just absolute quantifier that represents a crisp value like one or two, but we are also concerned with relative quantifier that represents a fuzzy value, such as low, medium, high, most, or some.

Linguistic variables with typical values

Linguistic variables	**Typical Values**
Openness (as one of five-factor model of personality)	low, medium, high
Fantasy	low, medium, high
Aesthetics	low, medium, high
Feelings	low, medium, high
Actions	low, medium, high
Ideas	low, medium, high
Values	low, medium, high

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- **Personality**

is set of predictable behaviors by which people are recognized and identified.

- **Personality traits**

"dimensions of individual differences in tendencies to show consistent patterns of thoughts, feelings, and actions.“ (Costa & McCrae, 1992)

Five factor model of personality

[A systematic presentation is given by Ören, Ghasem-Aghaee, 2003]

Personality is represented by

30 facets grouped under **5 traits** (factors):

Openness (intellectual, creativity)
Conscientiousness (moral, high goals to accomplish work successfully)
Extraversion (sociability, positive affect)
Agreeableness (nice person)
Negative emotions (negative affect)

This five factor model is also called OCEAN model

Personality Trait: Openness (OCEAN)

"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)

Personality descriptors based on the levels (or values) of the six facets of **openness**

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

openness

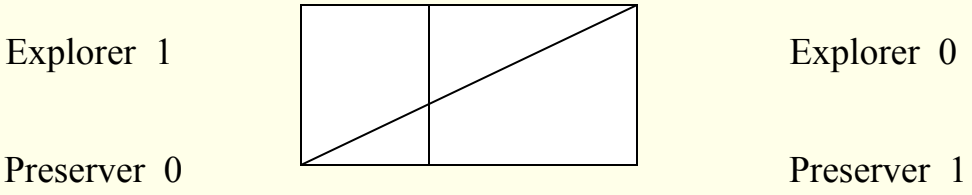
	low	medium	high
Personality type	**Preserver**	**Moderate**	**Explorer**
Personality characteristics	- Has narrower interests - Is more comfortable with the familiar - Is perceived as more -- conventional -- conservative - Is perceived not as -- more authoritarian	- Can explore the novel with interest 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)	- 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)

The continuum of openness - Example

Traits (as well as facets) are not binary valued!

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).



Continuum of openness

2. FUZZY PERSONALITY KNOWLEDGE

The knowledge in Tables 1-5 of Ören and Ghasem-Aghaee (2003) is used to generate the fuzzy knowledge-base.

As an example, we represent the knowledge associated with the fantasy and feelings facets of *Openness in the following table:*

2. Fuzzy personality knowledge and personality descriptor

facets	value	Personality descriptor (Howard & Howard, 2001a)
Fantasy	Low	focuses on here and now
	Medium	occasionally imaginative
	High	imaginative
		daydreams
Feelings	Low	ignores and discounts feelings
	Medium	accepts feelings
	High	values all emotions

Fuzzy Personality Knowledge: personality descriptors

Rules to represent *personality descriptors* based on the values of the facets of each personality factor.

Openness:

IF fantasy is low
THEN dO_fantasy is **focuses_on_here_and_now**.

IF fantasy is medium
THEN dO_fantasy is **occasionally_imaginative**.

IF fantasy is high
THEN dO_fantasy is **imaginative**.

Fuzzy Personality Knowledge: personality factors

- The value of the *personality factors* are based on the values of its facets.

- degree of a facet = measured value * weight factor

- degree(value) of a trait = degree(value) of the current dominant facet

Determination of the value of a trait (example) :

				degree (weighted value)
IF	fantasy	is	low	20
OR	aesthetics	is	medium	50
OR	feeling	is	high	80
OR	actions	is	low	20
OR	idea	is	high	90
OR	values	is	high	85
THEN	**openness**	**is**	**high**	**90**

IF openness is high d

THEN openness is **preserver** d (where d = **90** %)

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3. Definitions: Agents

3.1 Agents

3.2 Fuzzy agents

3.3 Agents with personality

3.4 Agents with dynamic personality

3.1 Definitions: Agents

- **Agents:** Agents are autonomous software modules with perception and social ability to perform goal-directed knowledge processing, over time, on behalf of humans or other agents in software and physical environments.
- The *core* knowledge processing abilities of agents include: reasoning, motivation, planning, and decision making.

Additional abilities of agents are needed to make them more intelligent and more trustworthy.

Abilities to make agents *more intelligent* include anticipation, understanding, learning, and communication in natural language.

Abilities to make agents *more trustworthy* as well as assuring the sustainability of agent societies include being