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Towards Fuzzy Agents with Dynamic Personality for Human Behavior Simulation

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This work is based on the personality knowledge as distilled from psychology.

(Ören and Ghasem-Aghaee, 2003a)

Plan

1. Fuzzy logic and fuzzy sets

2. Fuzzy personality knowledge

3. Definitions: Agents

4. Fuzzy agents with dynamic personality

5. Conclusions and on-going work

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 0.5 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.

Fuzzy logic:

- Effective techniques for handling fuzzy uncertainties with well-developed mathematical properties.

- Provides an excellent way to represent and process linguistic variables.

  - Their use considerably improves the bridge between mathematical models and the associate physical reality (Klir and Yuan 1998).

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
Negative Emotionality	low, medium, high
Worry	low, medium, high
Anger	low, medium, high
Discouragement	low, medium, high
Self-consciousness	low, medium, high
Impulsiveness	low, medium, high
Vulnerability	low, medium, high

Fuzzy sets on worry

(each point in fuzzy set = membership value / degree of worry)

Low worry   = (**1.0/10, 1.0/20, 0.5/30**, 0.0/40, 0.0/50, 0.0/60,
                      0.0/70, 0.0/80, 0.0/90, 0.0/100)

Medium worry = (0.0/10, 0.0/20, 0.0/30, **0.2/40, 1.0/50, 0.2/60**,
                      0.0/70, 0.0/80, 0.0/90, 0.0/100)

High worry   = (0.0/10, 0.0/20, 0.0/30, 0.0/40, 0.0/50, 0.0/60,
                      0.5/70, 1.0/80, 1.0/90, 1.0/100)

Worry

Low   Medium   High

Membership value

1.0

0.5

0.0

0   10   20   30   40   50   60   70   80   90   100
Degree of worry

Fuzzy sets on worry

Hedges in fuzzy logic

hedges	values
very	$\mu A (x)^2$
power (very very)	$\mu A (x)^n$ where n=3
somewhat	$\mu A (x)^{0.5}$
indeed	$2*\mu A (x)^2$ for $0 <= \mu A (x) <= 0.5$ $1-2(1- \mu A (x))^2$ for $0.5 < \mu A (x) <= 1$

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2. FUZZY PERSONALITY KNOWLEDGE

The knowledge in Tables 1-5 of Ören and Ghasem-Aghaee (2003a) 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

2. Fuzzy personality knowledge: Examples

- Group 1. Rules to represent *personality descriptors*

- Group 2. Rules to represent the value of the *personality factors*

- Group 3. Rules about the representation of *compound personality characteristics*

- Group 4:

  Rules about the behavioral approach to emotions

  Emotional rules about the personality modifications

- Group 5. Rules about the Personality changes over time

2.1 Fuzzy Personality Knowledge: Group 1

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**.

2.2 Fuzzy Personality Knowledge: Group 2

Rules to represent the value of the *personality factors* based on the values of its facets.

IF	fantasy	is low
AND	aesthetics	is low
AND	feeling	is low
AND	actions	is low
AND	ideas	is low
AND	values	is low
THEN	openness	is **preserver**.

A more general way to determine the value of a trait:

degree of a facet = measured value * weight factor

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

			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**

2.3 Fuzzy Personality Knowledge: Group 3

Representation of *compound personality characteristics*;
some examples follows (l_style, d_style: abbrevations for learning
style and decision style):

IF	extraversion	is high
AND	negative emotion	is low
THEN	l_style	is **independent**.

IF	conscientiousness	is low
AND	agreeableness	is medium
AND	negative emotion	is low
THEN	d_style	is **diplomat**.

2.4 Fuzzy Personality Knowledge: Group 4

Types of expression:

2.4.1 Behavioral expression (short-term)

2.4.2 Personality expression (long-term)

2.4.1 Fuzzy Personality Knowledge: Group 4

Rules about the **behavioral approach to emotions**:

IF   emotional_state   is fear
THEN   behavioral_expression   is **withdraw**.

IF   emotional_state   is anger
THEN   behavioral_expression   is **attack**.

IF   emotional_state   is joy
THEN   behavioral_expression   is **mate**.

Emotional rules about the **personality modifications** (PT: abbreviation for personality trait):

IF   emotional_state   is fear
THEN   PT_expression   is **timid**.

IF   emotional_state   is anger
THEN   PT_expression   is **quarrelsome**.

IF   emotional_state   is sadness
THEN   PT_expression   is **gloomy**.

IF   emotional_state   is acceptance
THEN   PT_expression   is **trusting**.

Personality changes over time - From age 20 to age 30, openness, extraversion, and negative emotionality tend to decrease, while conscientiousness, and agreeableness tend to increase (Howard & Howard 2001a):

IF   PT_agreeableness   is low
THEN   behavioral_expression   is **challenger**.

IF   PT_conscientiousness   is low
THEN   behavioral_expression   is **flexible**.

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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.

Agent definition references:

- Wooldridge and Jennings (1995)
- Maes (1995)
- Franklin and Graessor (1996)
- Jennings and Wooldridge (1998)
- Ören (2001)
- AgentLink (2002)
- Ören and Ghasem-Aghaee (2003)
- …

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 rational, responsible, and accountable. These lead to rationality, skillfulness and morality (e.g., ethical agent, moral agent).

3.2 Definitions: Agents

Fuzzy agents are agents that can perform qualitative uncertainty reasoning with *incomplete and fuzzy knowledge* in some environment that contains linguistic variables.

3.3 Definitions: Agents

Agents with personality are *fuzzy agents* with characteristics such as openness, conscientiousness, extraversion, agreeableness, and negative emotions in line with the five-factor personality theories to model human behavior.

3.4 Definitions: Agents

Agents with dynamic personality are *fuzzy agents* with personality where personality knowledge is updateable.
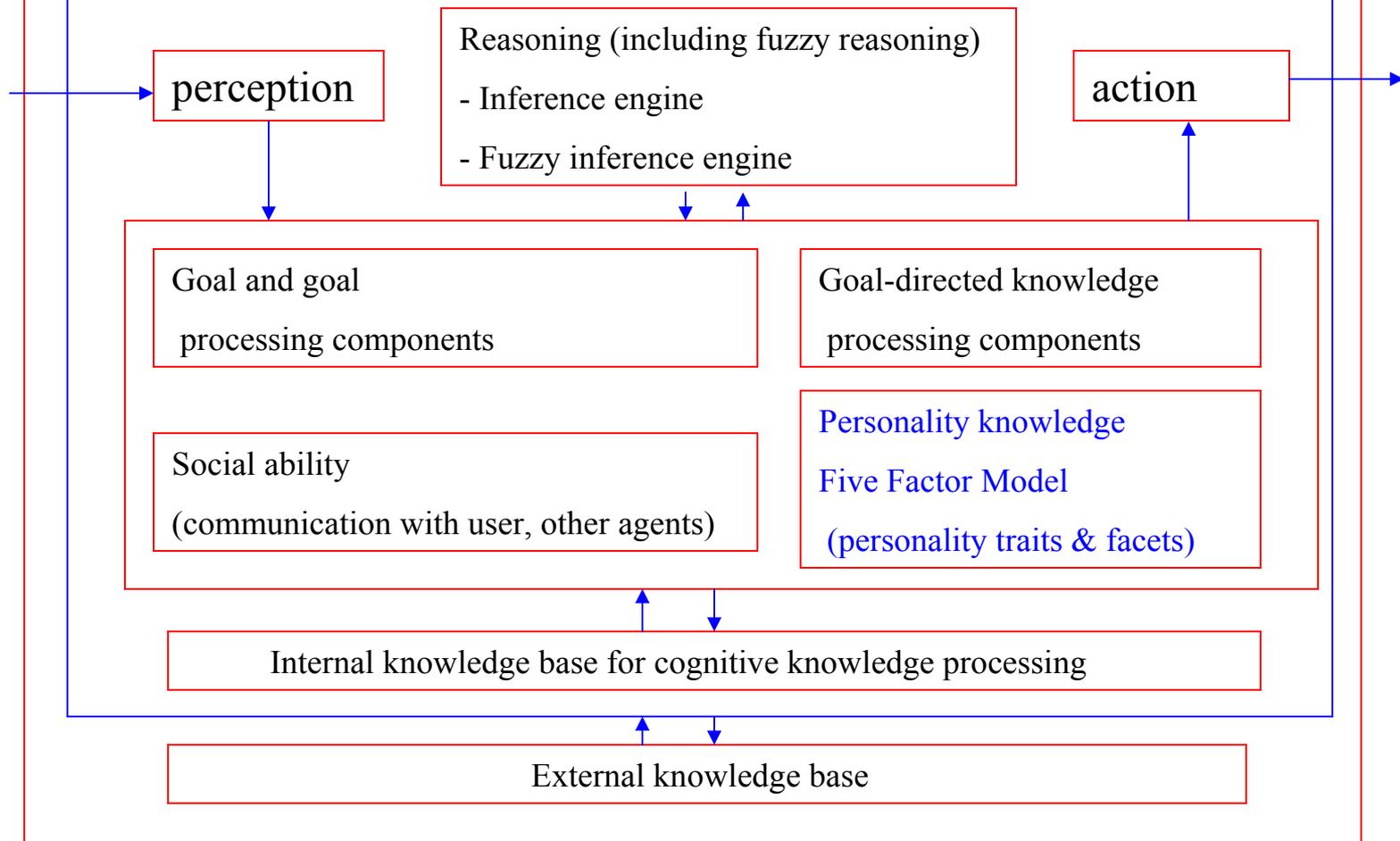
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4. Fuzzy agents with dynamic personality

When at least **any one of the 30 facets** changes its value, the personality may be affected and the model may be updated.

Components of agent with personality

perception

Reasoning (including fuzzy reasoning)

- Inference engine

- Fuzzy inference engine

action

Goal and goal

 processing components

Goal-directed knowledge

 processing components

Social ability

(communication with user, other agents)

Personality knowledge

Five Factor Model

 (personality traits & facets)

Internal knowledge base for cognitive knowledge processing

External knowledge base

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5.1 Conclusions

- The personality knowledge as specified by thirty facets clustered in five traits of the current personality theory is used as a basis to represent the behavior of fuzzy agents.

  (Costa and McCrae 1992, Acton 2001, Howard and Howard 2001a, b)

- The modifications of the values of personality facets can be used to re-evaluate the personality knowledge of an agent to allow personality updates and hence representation of dynamic personality.

5.2 On-going Work

Ghasem-Aghaee & Ören:

-   Simulation and Agents: Exploring the Synergy   (based over 250 refs)

- Functional Decomposition of Intelligent Agents with Personality

(with a taxonomy of 20 types of intelligence)

Ören & Ghasem-Aghaee:

- Agent Definitions and Agenthood: A Systematic Review, A
  Cluster Analysis, and A Proposal   (based on 32 definitions)

- Intelligent Agents, Simulation, and Human Behavior   (a book)

We have seen

- Fuzzy logic and fuzzy sets

- Fuzzy personality knowledge

- Definitions: Agents

- Fuzzy agents with dynamic personality

- Conclusions and on-going work