Effects of Cognitive Complexity in Agent Simulation: Basics

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Gist of the message: 1/2

1. Role of cognitive complexity of individuals
   in problem solving (coping with complexity)

2. Personality traits & software agents with personality

2.1 Agents with personality can represent

   human personality traits and personality facets.

2.2 Agents with dynamic personality can update the values of

   their personality traits based on changes

   in their personality facets

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Gist of the message: 2/2

3. As a personality trait,

   openness is related with cognitive complexity

4. 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.

5. In realistic representation (modeling) of humans by agents,
   this point of view may be useful.

Cognitive complexity

Based on Athey's work [Athey 1976], Ören [1978] elaborated on the importance of increasing cognitive complexity of an individual to increase his/her effectiveness in coping with complex situations.

As stated by Streufert and Swezey, [1986], persons who are high in cognitive complexity are able to analyze (i.e., differentiate) a situation into many constituent elements, and then explore connections and potential relationships among the elements

Characteristics of high and low cognitive complexity individuals

	High cognitive complexity people	**Low cognitive complexity people**
Information	More open to new information	opposite
Attraction	Attracted to high cognitive complexity people as well as to low cognitive complexity people	Attracted to low cognitive complexity people with similar attitude
Flexibility	More flexible in thinking More fluency of ideas in creativity	opposite
Social influence	Change attitude more easily	More stable in attitudes

Characteristics of high and low cognitive complexity individuals

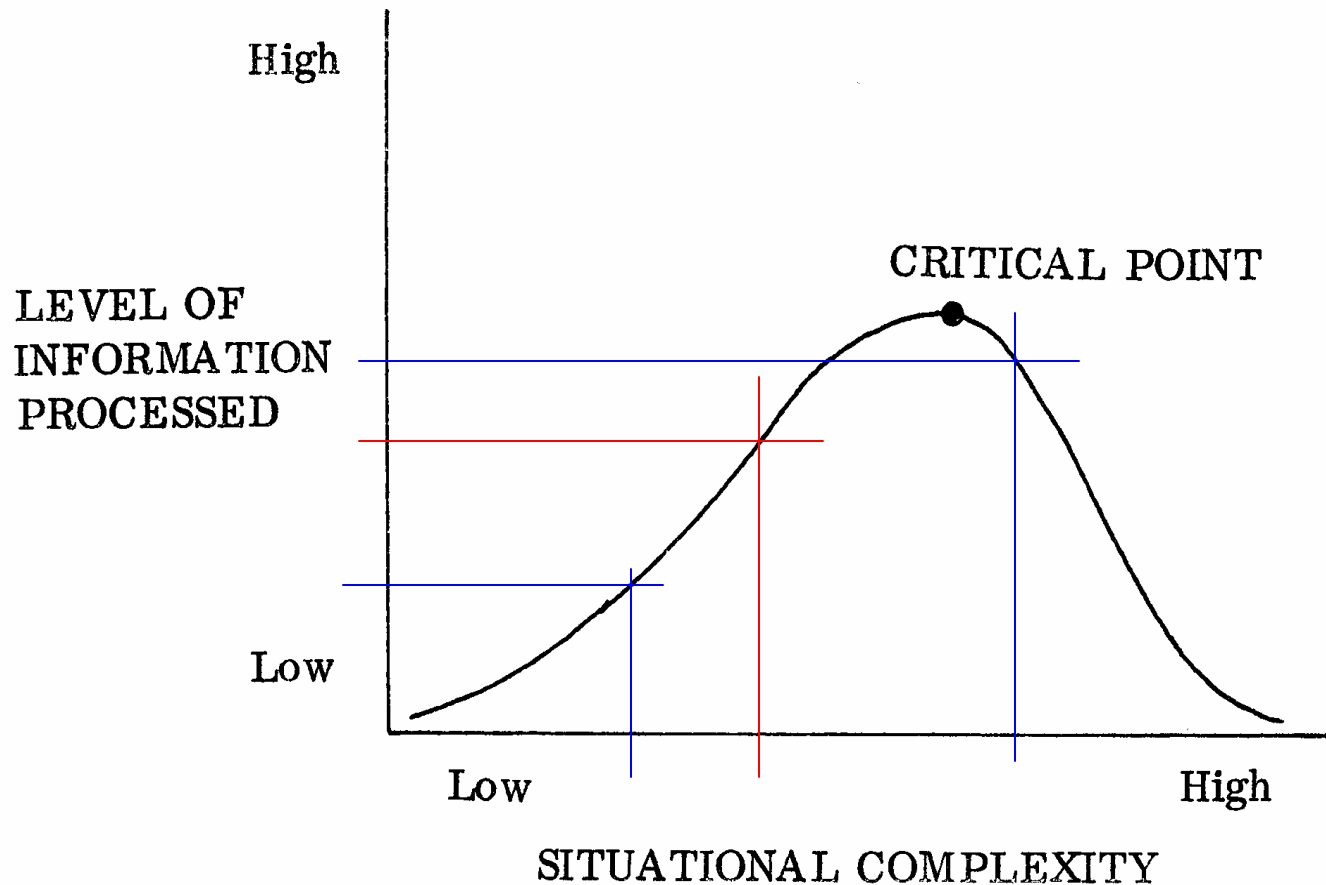|	**High cognitive complexity people**	**Low cognitive complexity people**
Problem solving	Tend to search for more information	opposite
Strategic planning	Greater flexibility in considering alternatives	opposite
Communication	More effective at a communication dependent task	opposite
Creativity	Able to generate more novel ideas	opposite
Leadership	Show leadership	opposite

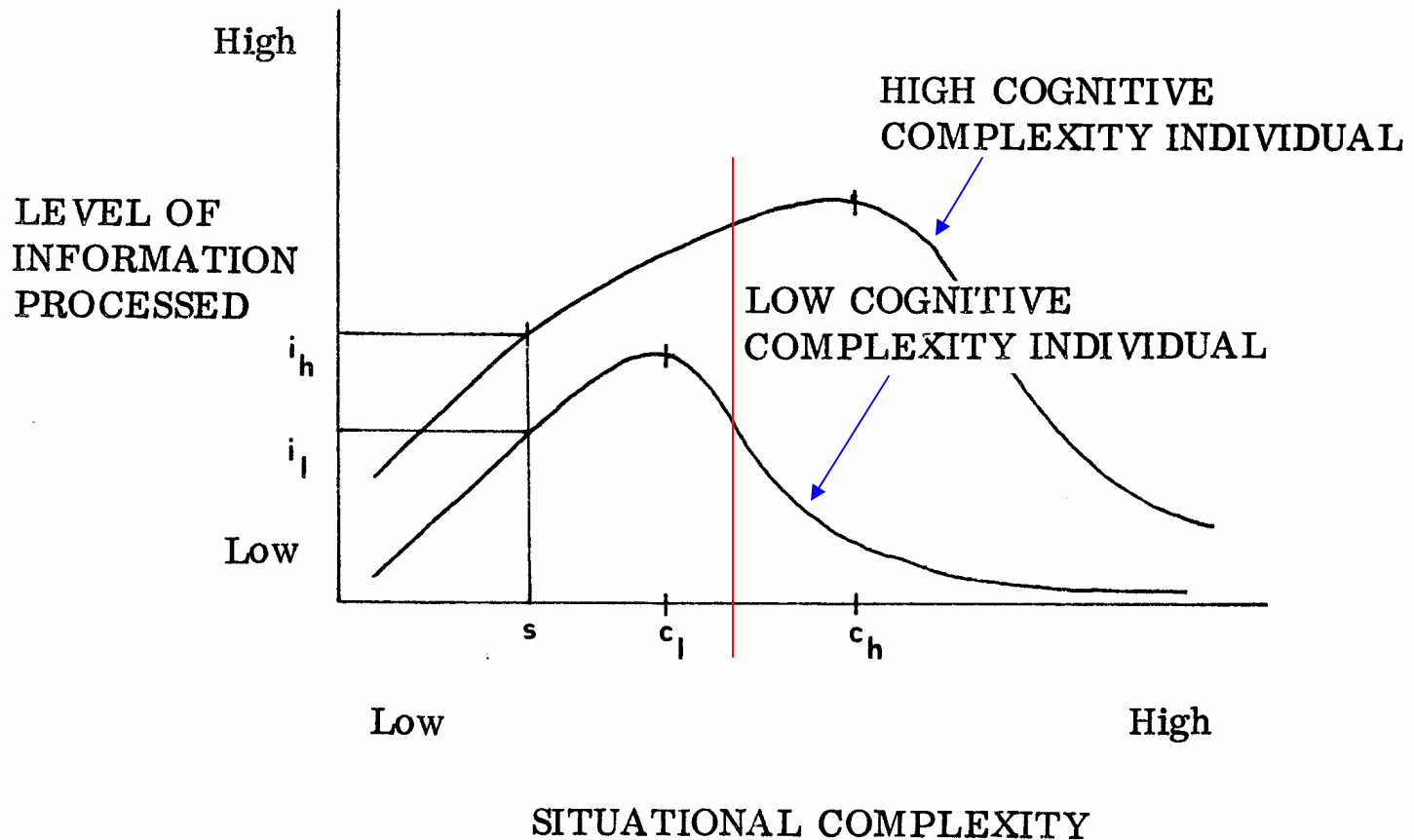Figure 1: Different levels of information processing of an individual depending on the situational complexity

Figure 2: Comparisons of information processing curves of two types of individuals, i.e., high and low cognitive complexity individuals

- **Personality**

is set of predictable behaviors by which people are recognized and identified.   (Costa & McCrae, 1992)

- **Personality traits**

"dimensions of individual differences in tendencies to show consistent patterns of thoughts, feelings, and actions."   (McCrae & Costa, 1990)

Five factor model of personality [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

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

Representation of Personality
[Ören, Ghasem-Aghaee, 2003]

- 1. **Primary** characteristics
  - 1.1. Personality template
  - 1.2. Personality vector
  - 1.3. Personality chart
- 2. **Compound** characteristics
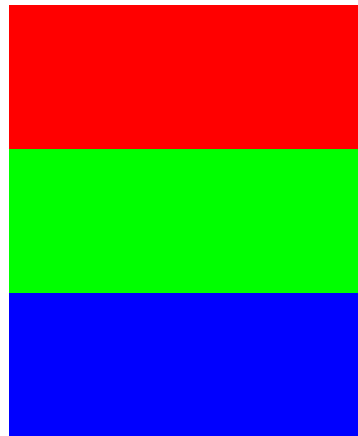
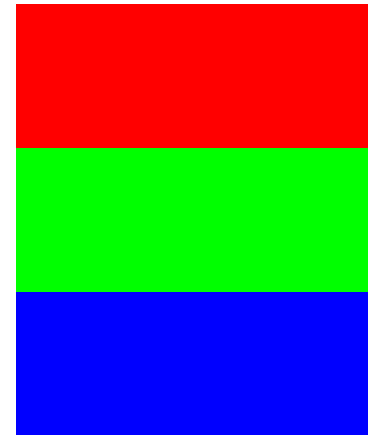# An analogy: Representation of color

Color A

Color B

0–255–255

180–0–100

Red   0

Green 255

Blue   255

Red   180

Green   0

Blue   100

Discrimination = 256^3 = 16 777 216

Concise representation of personality (1/2)

- 5 variables (personality traits)

  (each depending on 6 personality facets)

- Variables are linguistic;

  hence values are fuzzy, e.g.:

  – high, average, low (+, =, -)

  – very high, high, average, low, extremely low (++, +, =, -, --)

  normalized numerical values can also be used, e.g.:

  – 100, 50, 0

Representation of personality

Personality A

Personality
+, -, =, =, =

Personality
-, +, =, =, +

Personality B

O	+
C	-
E	=
A	=
N	=

O	-
C	+
E	=
A	=
N	+
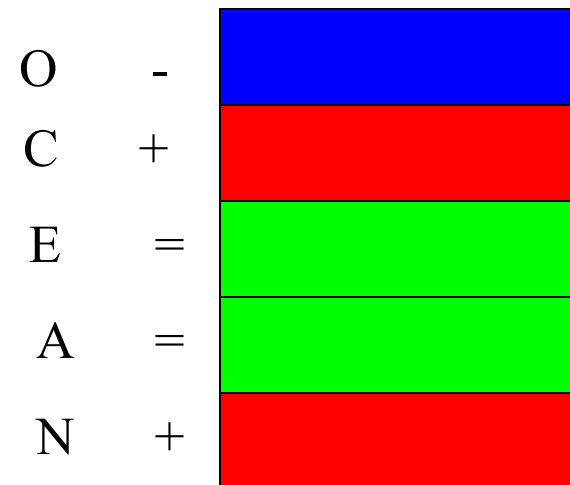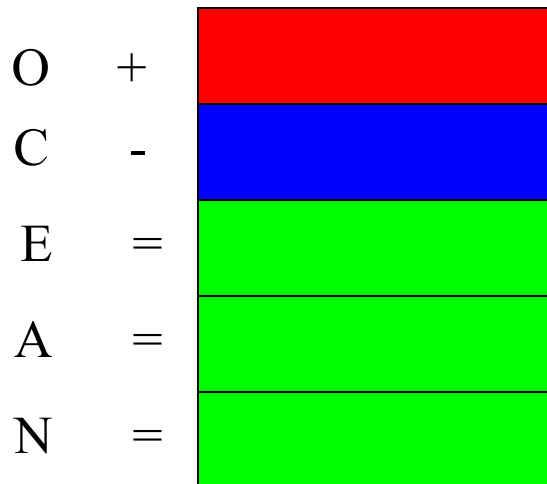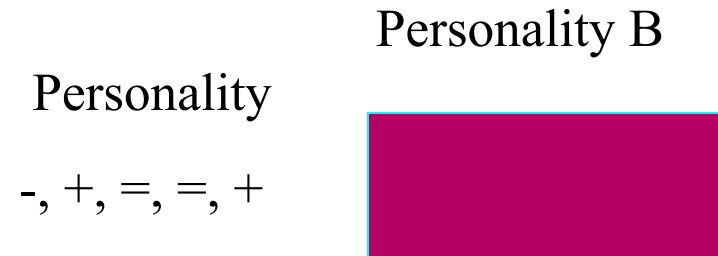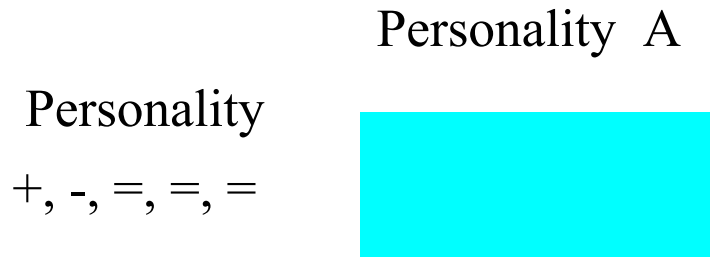
Discrimination: $3^5 = 243$; $5^5 = 3125$

Agents with dynamic personality are (*fuzzy) agents* with personality where personality knowledge is updateable.

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

| Personality type	**low** Preserver	**medium** Moderate	**high** 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)

Note: 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 (among others) by Ghasem-Aghaee and Ören (2003).
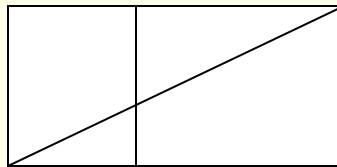
Explorer 1   Explorer 0

Preserver 0   Preserver 1

Continuum of openness

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

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

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.

The relationship of cognitive complexity and openness as a personality trait inspires applicability of personality update concept of dynamic personality to cognitive complexity.

The personality facets which affect openness are: fantasy, aesthetics, feelings, ideas, and values.

The dominant facet, i.e., the one having the largest weighted value determines openness. Any value change in any of the personality facets affecting openness may induce a personality update and change in the value of openness to affect the cognitive complexity of the individual.

Conclusions

- Openness, as a personality trait, is related with cognitive complexity.

- Hence, updates on openness may have implications on cognitive complexity and to the decision making ability of
  - humans as well as
  - agents in problem solving.

- In realistic representation (modeling) of humans by agents, this point of view may be useful.