Barcelona lecture-5

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Agent-Directed Simulation
& Agents with Dynamic Personality*

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Interests of the author:

Representation of human behavior by software agents in:

• Decision Making, Human Performance

• Advanced Human-System Interfaces (HSIs)

• Conflict Management Simulation

Represent the following aspects of human behavior:

• Personality (and its dynamic modifications)

• Emotions

• Culture

Develop personality, emotional, and cultural **filters**

1. Aims

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**
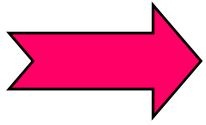
- Software agents

- Agent-directed simulation

- Human personality knowledge

- Representation of human personality

- Dynamics of human personality &
  Software agents with dynamic personality

- Cognitive complexity
  (in humans & software agents)

Types of knowledge processing and Software Agents

Types of knowledge processing:

- Procedural (algorithmic)

- Intentional

- Goal-directed

The roles of:
the **users** and **computational systems**
are different in each computational paradigm

Type of knowledge processing	Computational Paradigms	User's role	Computational system's role
Procedural	**Algorithmic** (e.g., unstructured, structured, object-oriented programming)	- Analyst *develops an algorithm* - Programmer *transforms* the algorithm and generates a *program* - User *activates the program*	- System *executes* the (compiled or interpreted) program *code*

Type of knowledge processing	Computational Paradigms	User's role	Computational system's role
Intentional	**Declarative**	- User *specifies* the problem	- System *generates a code* (i.e., program generator *transforms* the specification into code) - System *executes the* (compiled or interpreted) *code*
	Event-based	- User *activates functions* to be performed (indirectly activates the module(s) of code to be executed)	- System assures the *execution of the software modules* corresponding to the selected functionalities

Type of knowledge processing	Computational Paradigms	User's role	Computational system's role
Goal-directed	**AI-based** (e.g., heuristics, rule-based computation, frame-based computation)	- Knowledge engineer specifies the rules - User *specifies* the *facts* and the *goal*	- *Inference engine* is prepared only once. - System (the inference engine) determines the order in which the rules have to be executed and *executes the rules* accordingly until the goal is satisfied.
	Agent-based	- User *specifies the goal* and *delegates* finding a solution of the problem to agent(s).	- Agents *analyze the goal (goal processing)* - If necessary can *perceive* their environment - *Decide* which software modules (other agents or non-agent software modules) to activate to subdelegate the task(s) - And can perform goal-directed knowledge processing.

- **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 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).

Infohabitants can best be represented by software agents.

Hence, **realistic cognitive abilities of software agents** such as influence of personality to decision making and problem solving **is** of **practical computational importance**.

- Software agents

- Agent-directed simulation

- Human personality knowledge

- Representation of human personality

- Dynamics of human personality & Software agents with dynamic personality

- Cognitive complexity (in humans & software agents)
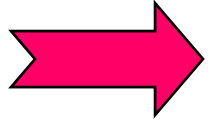
Simulation for Agents: Agent Simulation

Agent-directed Simulation
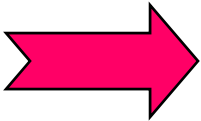
Agents for Simulation: Agent-supported Simulation   Agent-based Simulation

Simulation for agents

• **Agent simulation**: simulation of agent systems in engineering, human and social dynamics, military applications etc.

Agents for simulation

• **Agent-supported simulation**: use of agents as a support facility to enable computer assistance in problem solving or enhancing cognitive capabilities;

• **Agent-based simulation**: the use of agents for the generation of model behavior in a simulation study

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Remember the challenge:

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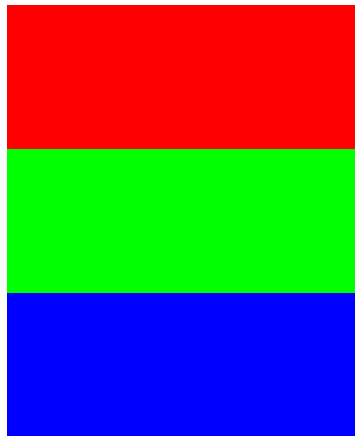
Donald Knuth, 1968

Hence, we need to know human personality, its representation, and its processing (before even attempting to simulate human personality)

An analogy: Representation of color

	Color A	Color B
	0–255–255	180-0-100

R_{ed} 0 R_{ed} 180

G_{reen} 255 G_{reen} 0

B_{lue} 255 B_{lue} 100

Discrimination = **256^3** = 16 777 216

Q: Can we represent and process knowledge about human personality as we can represent knowledge about colors?

A: Yes we can!

We will see "how," later.

First, about human personality.

- **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

Personality is represented by
   30 facets grouped under **5 traits** (factors):

   Openness
   Conscientiousness
   Extraversion
   Agreeableness
   Negative emotions

This five factor model is also called OCEAN model

History of the five personality factors

- The evidence in support of a five factor view of personality structure has been accumulating for over 50 years.

- The first evidence for the five factor model apparently was published in 1949, by D. W. Fiske.

- The report of his findings sat in relative obscurity until the early 1960s, when Norman [1963], Borgotta [1964], and Smith [1967] approached the same research question with different instruments.

Factor analysis

- Factor analysis is a basic tool for researchers seeking to identify the fundamental traits of personality.

- Factor analysis builds on the correlation coefficients. The correlation coefficient measures the degree of relationship between two variables.

- The correlation coefficient can range from:

  0.00 (no relationship) to

  +1.00 (high positive relationship).

Factor loadings of IPIP-NEO facets

Facets	O	C	E	A	N
O1: Imagination	**.71**	-.15	.07	-.08	.16
O2: Artistic Interests	**.58**	.10	.27	.31	.10
O3: Emotionality	**.50**	.15	.28	.23	.37
O4: Adventurousness	**.54**	.07	.39	-.08	-.30
O5: Intellect	**.78**	.21	-.05	-.08	-.22
O6: Liberalism	**.60**	-.23	-.07	.06	.01
N1: Anxiety	.00	-.05	-.22	.02	**.87**
N2: Anger	-.03	.09	-.08	-.36	**.75**
N3: Depression	.07	-.31	-.30	-.08	**.73**
N4: Self-Consciousness	-.09	-.32	-.47	.22	**.55**
N5: Immoderation	.10	-.33	.23	-.23	**.50**
N6: Vulnerability	-.10	-.31	-.11	.06	**.83**

Personality knowledge references:

- Costa and McCrae (1992)
- Acton (2001)
- Howard (2000)
- Howard and Howard (2001a, b)
- …

3.1 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 re-examining 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).

Explorer 1

Preserver 0

Explorer 0

Preserver 1
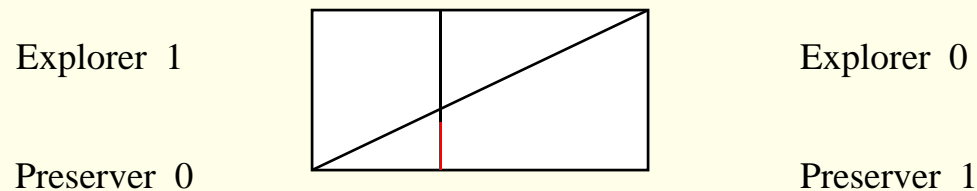
Continuum of openness

3.2 Personality Trait: Conscientiousness (OCEAN)

- "Conscientiousness is the tendency to set high goals, to accomplish work successfully, and to behave dutifully and morally"

  (Acton-glossary).

- "Conscience is the awareness of a moral or ethical aspect to one's conduct together with the urge to prefer right over wrong."   (AHD)

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

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

conscientiousness

	low	medium	high
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	Executive High achievers Leaders

3.3 Personality Trait: **E**xtraversion (OC**E**AN)

"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)

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

Facets of extraversion	Levels		
	low	medium	high
Warmth	reserved, formal	attentive	affectionate, friendly, intimate
Gregariousness	prefers to be alone	alone/with 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

extraversion

	low	medium	high
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

3.4 Personality Trait: **A**greeableness (OCE**A**N)

" <u>Agreeableness</u> is tendency to be a nice person"   (Acton-glossary)

" Agreeableness refers to the number of sources from which one takes one's norms for right behavior."

(Howard and Howard, 2001a)

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

Facets of agreeableness	Levels of agreeableness		
	low	medium	high
Trust	cynical skeptical	cautious	sees others as honest & well-intentioned
Straightfor-wardness	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

agreeableness

	low	medium	high
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 acquiring and exercising power - Moves against people - Tough-minded - In the extreme becomes: -- narcissistic -- antisocial -- authoritarian -- paranoid personality	- 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 - 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

3.5 Personality Trait: Negative Emotionality (OCEAN)

"Negative Emotionality or neuroticism 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)

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

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

negative emotionality

	low	medium	high
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	Academicians Customer service professionals Social scientists

- Software agents

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➡ • Representation of human personality

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Representations of personality

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)*.

Representations of personality

1. **Primary** characteristics

      1.1. Personality vector

      1.2. Personality template

      1.3. Personality chart

2. **Compound** characteristics
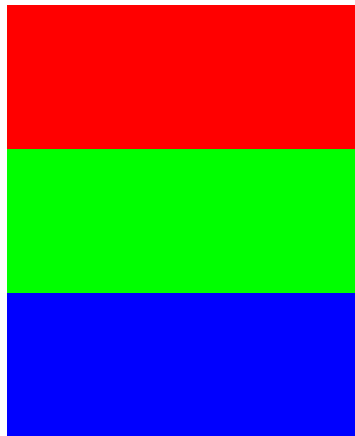
Concise representation of personality:

- 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

An analogy: Representation of color

Color A	Color B
0–255–255	180-0-100

R_{ed} 0 R_{ed} 180

G_{reen} 255 G_{reen} 0

B_{lue} 255 B_{lue} 100

Discrimination = 256^3 = 16 777 216

Representation of personality

	Personality A		Personality B
	+, -, =, =, =		-, +, =, =, +

O	+		O	-
C	-		C	+
E	=		E	=
A	=		A	=
N	=		N	+

Discrimination: $2^5 = 32$; $3^5 = 243$; $5^5 = 3125$

Personality vector:

Representation of an
explorer, focused, ambivert, negotiator, and reactive
personality

Personality traits		symbolic/ qualitative value	numeric value	Personality type
Openness	O	+		explorer
Conscientiousness	C	+		focused
Extraversion	E	=		ambivert
Agreeableness	A	=		negotiator
Negative emotion	N	+		reactive

Personality template – for the OCEAN model

	personality traits/ facets	weight	symbolic/ qualitative value	numeric value	descriptors
Openness			.		
O1	Fantasy				
O2	Aesthetics				
O3	Feelings				
O4	Actions				
O5	Ideas				
O6	Values				
Conscien-tiousness			.		
C1	Competence				
C2	Order				
C3	Dutifulness				
C4	Achievement striving				
C5	Self-discipline				
C6	Deliberation				
…	**…**				

Transformation of personality template to personality vector

For each of the 5 traits:

    For each of the 6 personality facets:

        - get the weighted numerical value of the facet

        (= weight * numerical value)

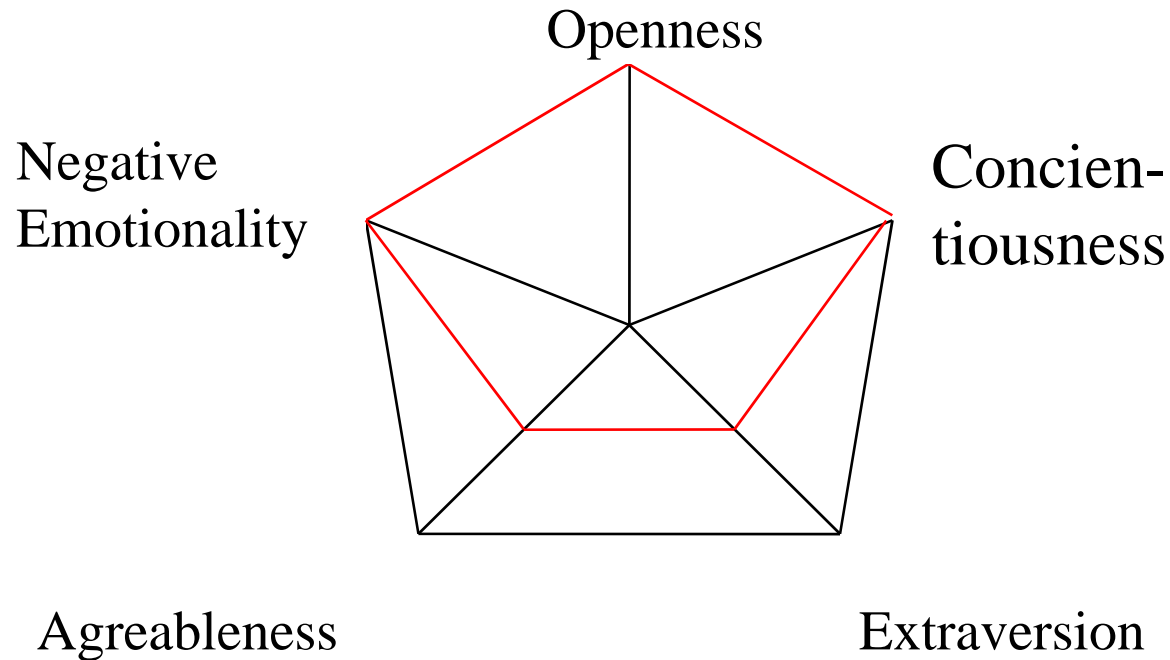   **then the dominant value (the highest value)**

        determine the value of the trait

Personality Charts

- A personality chart is a Kiviat chart (or a web chart).

- The number of axes is equal to five

   (which is (the current perception of) the number of personality traits).

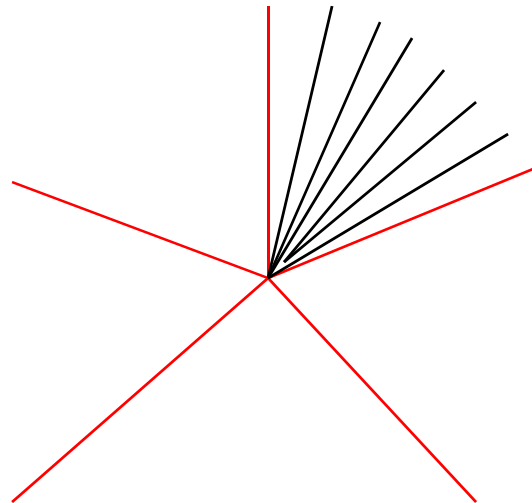# Personality Charts   (OCEAN)

Personality Charts   (OCEAN)

(A variant chart: **Personality facet chart**)

Between two traits, six facets can be drawn to represent the values of the weighted facets.

(This may be useful for **personality management**)

# Vector representation of personalities for different conflict style

	sv	negotiator	sv	aggressor	sv	submissive	sv	avoider
O(penness)								
C(oncientious-ness)	=	balanced	+	focused	-	flexible	-	flexible
E(xtraversion)	=+	ambivert/ extrovert	+	extrovert	-	introvert	-	introvert
A(greableness)	+	negotiator	-	challenger	+	adaptor		
N(egative emotion)	=	responsive	+	reactive	-	resilient	+	reactive

sv – symbolic value

The reference text contains examples on:

- leadership styles,

- learning styles, and

- problem solving styles

- Software agents

- Agent-directed simulation

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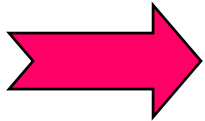
Dynamics of Personality

This possibility is very important

- The values of the personality **facets** may be modified according to the desired personality traits.   *(Howard, 2000, pp. 756-761)*
- The personality traits change also by age.   *(Howard, 2000, p. 439)*

- After updating the values of the facets
  - one can reassess the personality of an individual and then
  - a new personality template and associated personality vector can represent the new personality.

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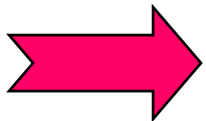
Motivation to know Cognitive Complexity:

1. Role of cognitive complexity of individuals in problem solving (coping with complexity)
2. As a personality trait, *openness* is related with cognitive complexity
3. 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.
4. 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
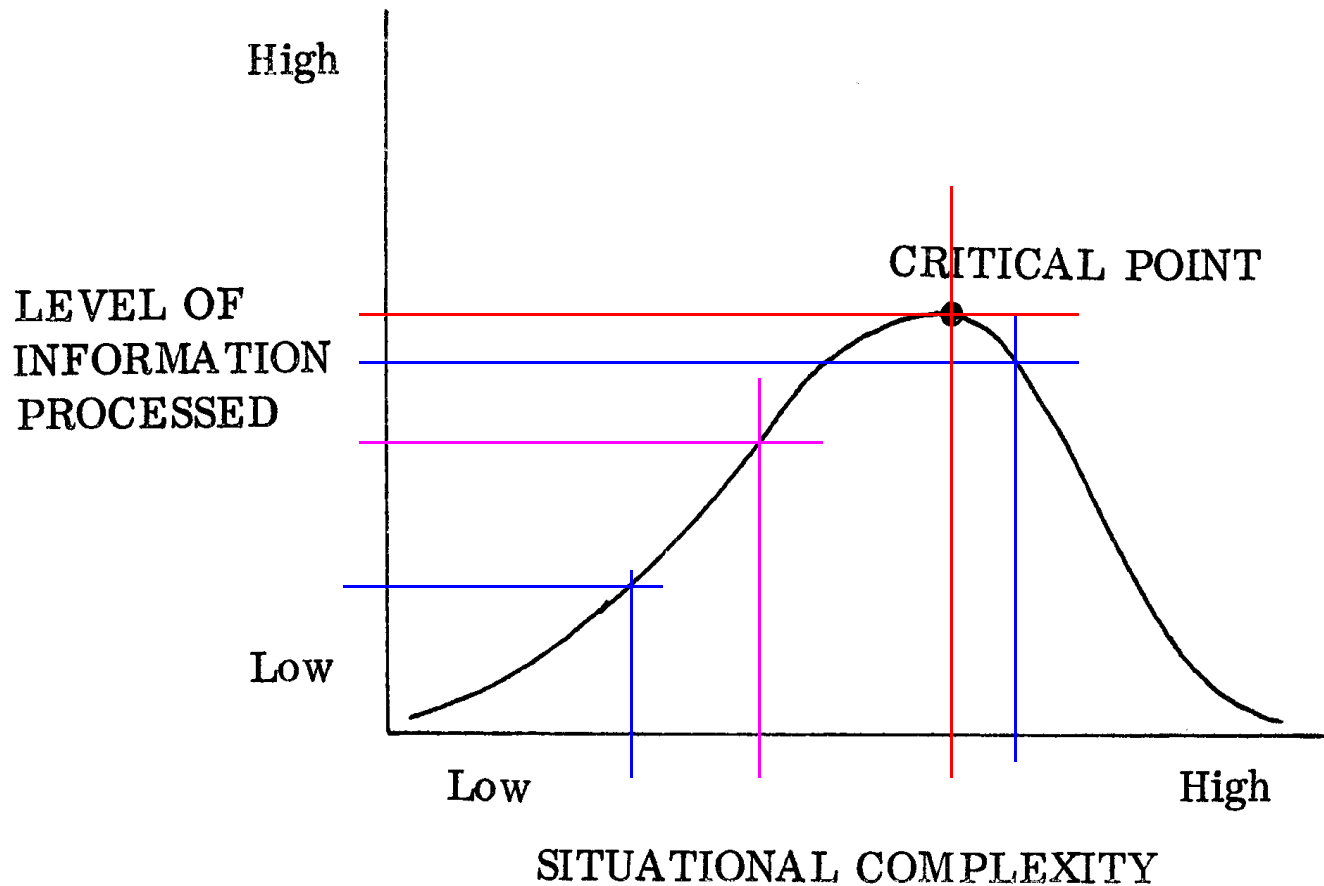
Figure 1: Different levels of information processing of an individual depending on the situational complexity
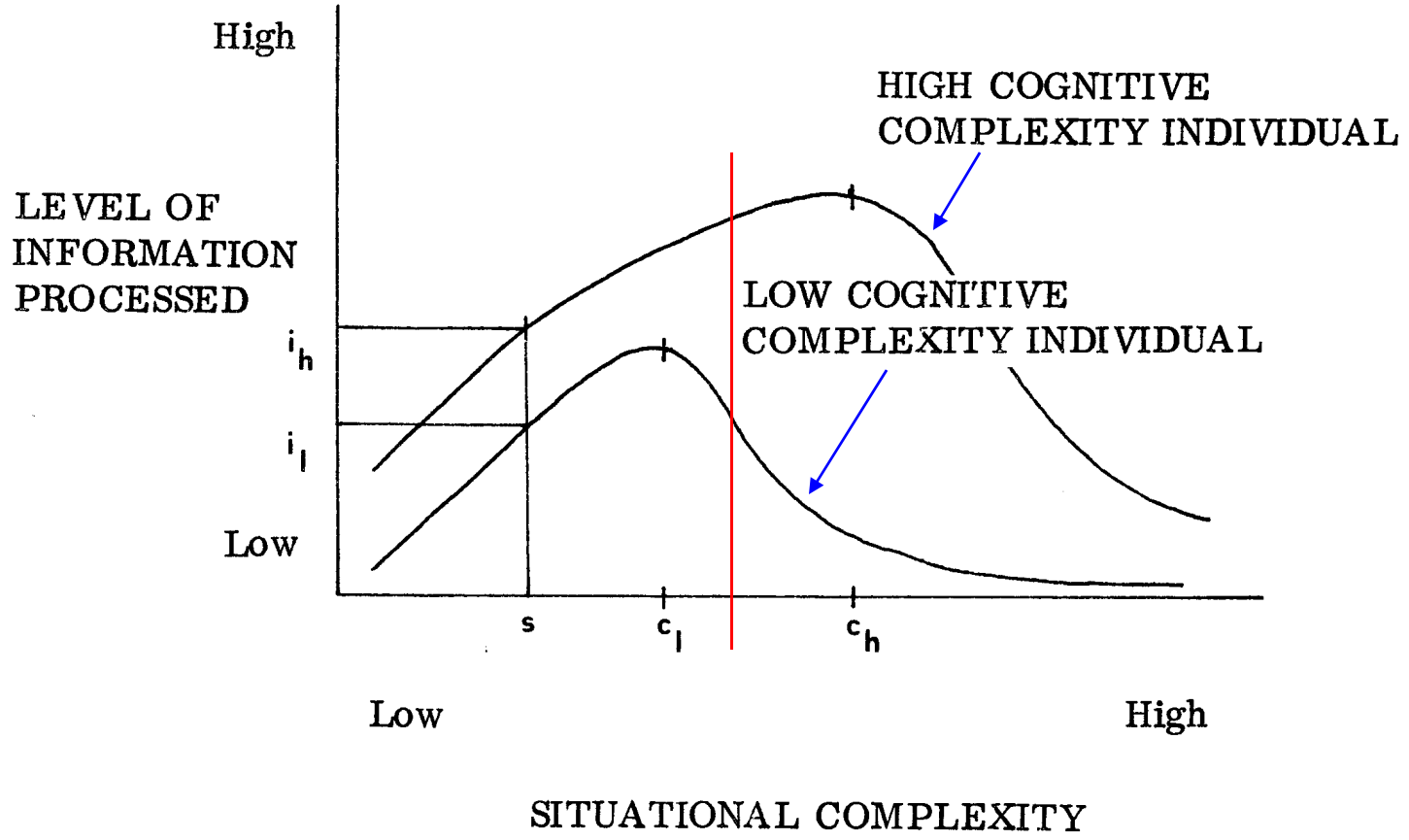
Figure 2: Comparisons of information processing curves of two types of individuals, i.e., high and low cognitive complexity individuals

Characteristics of High and Low Cognitive Complexity People:

	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

	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

- 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.

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Publications and Presentations of Dr. Tuncer Ören on:
Cognitive Simulation:
Personality, Emotions, Perception-Anticipation

http://www.site.uottawa.ca/~oren/pubsList/HBS.htm

2003

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

Ghasem-Aghaee, N. and Ören, T.I. (2003). <u>Towards Fuzzy Agents with Dynamic   Personality for Human Behavior Simulation,</u> Proceedings of the 2003 Summer Computer Simulation Conference, Montreal, PQ, Canada, July 20-24, 2003, 3-10. <u>(presentation)</u>

2004

Ghasem-Aghaee, N. and Ören, T.I. (2004). Effects of Cognitive Complexity in Agent Simulation: Basics Proceedings of SCSC 2004 - Summer Computer Simulation Conference, July 25-29, 2004, San Jose, CA., pp. 15-19. (presentation).

Ören, T.I. and L. Yilmaz (2004). Behavioral Anticipation in Agent Simulation, Proceedings of WSC 2004 - Winter Simulation Conference, Washington, D.C., December 5-8, 2004, pp. 801-806. (presentation)

2005

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Thank you for your attention!