Artificial Intelligence and Cognitive Psychology
Applications, Models

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Abstract

How can we connect artificial intelligence with cognitive psychology? What kind of models and approaches were developed in these scientific fields? The main aim of this paper is to provide a broad summary and analyses about the relationships between psychology and artificial intelligence. I present the state of the art applications, human like thinking and acting systems (Human Computer Interface, Modelling Mental Processes, Data Mining Application) Application can be divided into several groups and aspects. Main goal of the artificial intelligence was/is to develop human level intelligence, but the technology transfer turned out to be much comprehensive, and these systems are used widely, and the research is blooming.

The first part of the paper introduces the development, and the basic knowledge, general models of the cognitive psychology (gives also its relevant connecting points to artificial intelligence), it describes also the information processing model of the human brain.

The second part provides analyses of the human computing interaction, its tasks, application fields, the psychological models used for HCI, and the barriers of the field. In order to extend or defeat these barriers, the science has to face several scientific, pragmatic, and technical challenges (such as the problem of complexity, disturbing coefficients... etc). Other important area demonstrated in this paper is the mental modelling used to prevent, prognoses, manipulate, or to support the human mental processes, like learning. By a prognoses (for example prognoses of the children affected by mental illnesses according to their environments. etc), data mining, knowledge discovery, or expert systems are applied. The paper gives an outline about in the system used coefficients, and analyses the missing attributes.

The last part deals with the expert systems used to help people and relatives with autism and with the life simulation (applied mental model) in the virtual reality/virtual environment.

The goal of the present paper is to introduce the different approaches, models of the artificial intelligence and cognitive psychology, and gave an outline of the scientific fields.

1. Psychology und Artificial Intelligence

"Unser Denken ist mit einer tieferen
Bewusstseinsschicht verbunden,
die in Form von Fantasie und
Mythen zu uns spricht." C.G.Jung

Psychology is one of the basic sciences of artificial intelligence (AI). The founder of the psychology is Wilhelm Wundt (1832-1920), who engaged in empirical methods, and was interested in the thinking processes during his scientific work. The main goal of the science is to model human thinking (in AI the Human Computing deals with this question), but also an other question rose: How can we solve psychological, human-near questions or problems with artificial intelligence methods? If we possess the detailed description of the brain, it will enable us to model this on computer, for example: a broader understanding of natural language processing, understanding emotional intelligence, sight.
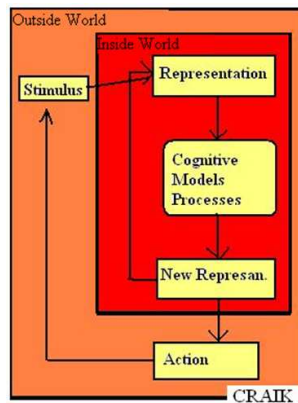

Figure 1: Information Processing Model of the Human Brain

Psychology had two main leading schools: *behaviourism*, and *cognitivism*.
Behaviourism: Refused the theory of the mental processes, and insisted to study the resulted action or the stimulus strictly objective. The representatives of this theory have been decreasing with time.
Cognitive psychology: The brain is an information processing device. Artificial Intelligence supports also this idea, and the first picture illustrates the information processing model of the brain. [1]
   1) Stimulus has to be interpreted to representation

2) Representation is manipulated via cognitive processes, and builds new inside representation
3) Process may end in an action.[1]

According to Craik (scientists dealing with knowledge based agents, and died in an unfortunate accident) the organism contains a possible small model of the outer world, and the possible actions, is also able to try different alternatives, and decide by the best, react before an expected future happens, or to analyse the consequences of the past, and react the most competent and safe way on a situation. (Craik, 1943)

AI Relevant psychological theories :(Not complete)

Scientist	Statement
Alfred Adler	Serial killers have suffered 100% under violence in their childhood.
Eric Berne	Children without physical contact showed physical and intellectual setback.
Robert Bolton	Communication skills are learned from our family members.
Freud	Ego, Superego, subconscious
Edward de Bono	Brain connects concepts to patterns. Lateral (including logics)
Isabel Briggs Myers	Human can understand reality: intuitively or with perceptions.
David D. Burns	Emotion are cognitive processes or the consequences of thinking
Howard Gardner	Main art of intelligences: language, musical, body, interpersonal, intrapersonal. Every human is an individual combination of these intelligences.

Table 1: AI relevant psychological theories

2. Human Computing Interaction

We may come in a contact with HCI every day, because this field includes the every day use of computer, the user interfaces and expert programs which may use cognitive psychology in order to manipulate or help people. In this paper, those tasks will be introduced where psychology has a relevant connection.

2.1. Multimodal HCI

Multimodal HCI comprehended the art how to make people computers more understandable. It includes understanding the following three main parts: [8]
- user
- system
- Connection between user and system.

It is important in the HCI to understand the goals, intention of the user the problem solving ability (with psychology), to understand the interaction (sociology), and to understand the physical ability of the users (ergonomic), to develop

a useful interface (graphical design), and to develop a system (computer science). HCI application can be found also in Virtual Reality.[8]

Virtual Reality is a new way of the human machine communication, which enables an interaction connecting to human senses. Stereo display systems provide for the user the experience of a real spatial representation, other systems provide also a possibility for a natural and intuitive direct interaction. An interesting technology is for example the modern tomography technology, CT, MRI (representing the human anatomy very detailed). Virtual environment provides 3D data sets. The main component of the user interface is to recognise, and analyse the hand gestures.

Virtual Environment is an important part of Virtual Reality, because more and more people connect to them. In these artificial environments (for example: games), human like attributes are relevant. Virtual human may posses several parameters: mental states (which produces emotional connection to the player), emotions, personality, memory, social norms behaviour, intelligence, motivation, are connected to sensors to be able to react on outer stimuli. The 2. Picture illustrates the possible mental model of a virtual human. Technologies of Artificial Intelligence provide a basis for the dream of the virtual reality. (N.M.Thalmann) Social Norm includes status, rules of information and interaction, control of the process, nonverbal social interaction. [7]
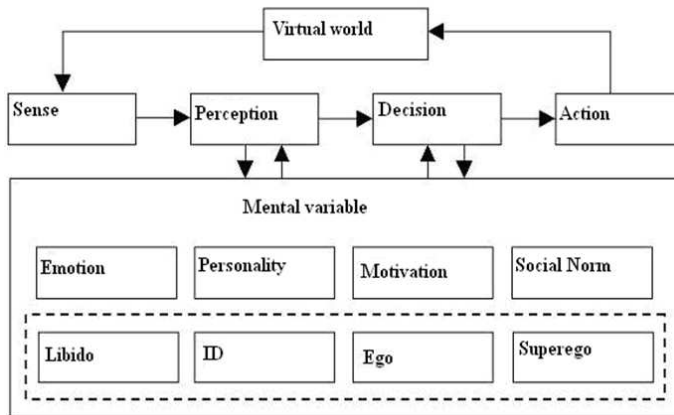

Figure 2: Mental Model of a Virtual Human

Other important approaches: New trend of the researches in HCI are the audiovisual speed recognition systems, and engineers are also working on the problem, to make the HCI systems able to react correctly on the state of the people. The research still has its barriers.

- mobile phones, virtual environment
- Arts. handicapped people
- Public and private spaces, learning supports. [9]

Many users have problems with understanding, learning, memorising the information appearing on the computer display. Cognitive theories provide a help in

the problem, that a simple user is unable to fit the information on the display into their mental models. Generally, HCI doesn't deal with the general goal of the work, and several qualities, like emotional states render the understanding more difficult. In the beginning HCI ment delegation and manipulation where the user controlled the devices like mouse, keyboard. But we cannot shut out the psychological processes out of the HCI. Actions are changes taking place in some milliseconds. Lost messages of the behaviour can be the following:

- Emotional and behavioural states (like: fear, joy)
- Manipulation (self and environment)
- Symbols (culture dependant symbols)
- Illustration (finger)
- Controls (like smile, look) [10]

Understanding these signs includes the following tasks:

- Analyses/understanding of the signs of the behaviour: body language, non-verbal signs.
- Understanding the environment/context (with behaviour)
- Understanding human behaviour based on the first two points.

The most techniques are based on the Gauss Model; the model of probability learning, but the following techniques also exists:

- Model based (Geometrical forms represents the fingers or the head)
- Appearance based (colours, textures)
- Outstanding point based (Observes extreme changes in space, and time, or by the activity of body, hands)
- Space-time based (The system understands body language as a change in space and time)

Scientific	Technological
Modality	**Initialisation**
Face, body, voice, combination of them	Initialisation is a slow and manual process
Fusion:	**Robostusness**
What is the abstraction level of the fusion of the modality	Human sensing is proceeded in an artificial environment. No ability to sense fast motions
Fusion and Context:	**Speed**
The fusion is context dependent	Systems are not enough fast. No bases for interactivity
Dynamics and Fusion	**Teaching, reinforcement**
Teaching vs. Training	Integration of different research groups.
Ability for both teaching and training	Need for a standard system.

Table 2: Scientific and Technological challenges of HCI

3. Mental Modelling

Artificial Intelligence can also be applied for predicting mental processes. The main goal of this research is the fact, which the numbers of the mental illnesses

are increasing, information is contradictory, and data bases are growing. One research field is for example: to detect and model Alzheimer. Mental state of a human depends on outer stimuli and inner cognitive processes. The main parts of the mental state are the following: [6]

- Emotion
- Motivation
- Personality
- Social Norm

3.1. Prevention of Mental Disorders

The numbers of mental ill people are globally increasing from year to year, despite of the increasing number of researches (researches are mainly dealing with genetic, and environmental facts. Only in the USA, 7, 5 million children are involved in these illnesses, and from 1994 there exists a research which tries to prevent the endangered children. The research will provide a model in which psychologists will be able to encroach in the development of the children in time. [4]

Mental illnesses are illnesses which disturber or limit people in their goals, the quality of life. It is also a psychological or behavioural pattern that occurs in an individual and is thought to cause distress or disability that is not expected as part of normal development or culture.[6]

3.2. Knowledge discovery, data mining

The World Health Organization predicted that depression would be the world's leading cause of disability by 2020. The recognition that mental health is costly and many cases will not become chronic if treated early has lead to an increase in research in the last 20 years. One method for modelling and preventing the mental models is the knowledge discovery, and data mining. [4]

The conclusion of the work was that children with alcoholic parents are in more percent in a dangerous situation. In the model 20 different attributes played a main role. The result the outcome data was whether the child is retarded or not. The algorithm concluded that the main risks are emotional and behavioural problems.

3.3. Data mining for mental illnesses

Knowledge Discovery and Data mining (KDD) methods are emerging as useful tools to learn structure from data. They differ from traditional methods by its well defined goal of elucidating domain models such as decision trees, rules, graphs etc. from data. The KDD process involves many steps encompassing data pre-processing (attribute selection, recoding etc.), choice of data mining algorithms, running protocol and post processing of the output. A simple KDD model constitutes an input of processed data to the data mining engine (one or more pre-selected algorithms) and the output is "knowledge" in the form of an understandable structural model of the input data Meanwhile, the Artificial Neural Network (ANN)

was introduced to the research of AD Artificial Neural Network (ANN) could get higher sensitivity and accuracy of classification than the traditional discriminate function analysis.[5]

Simulated Annealing has been widely and successfully used to solve global optimization problems in many fields, including training of Ann's. With logistic regression analysis, after adjustment for confounding, only education and incoming were independently associated with CMD. With the experiments with neural networks the variables which showed higher relation with CMD were years of schooling, *marital status, Sex, working conditions, possession of house, incoming and age.* [3]
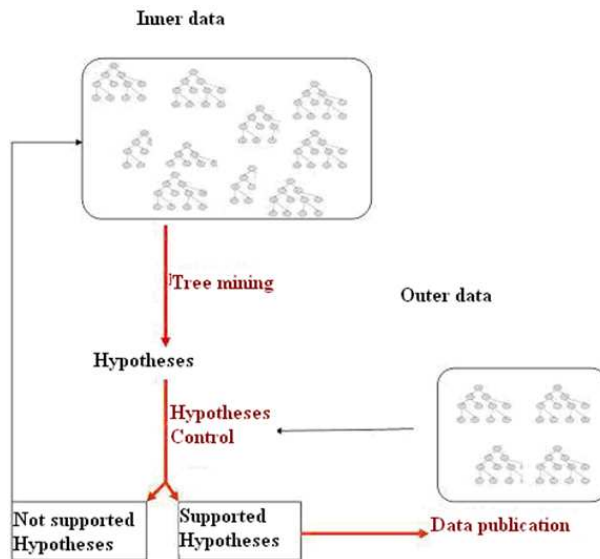

Figure 3: Hypotheses control, and support by mental illnesses

3.4. Expert Systems- Discovering, dealing with Autisms

Autisms are also a mental disorder which could be detected in childhood. If the diagnostics happens in time, it can lead effective help/therapy. The main goal of our study is to develop technological aids, which will help Autistic individuals to be identified earlier and initiate early intervention for the management of autism. (System developed in Indian) The AI Gaming Systems imparts valuable training to the child using the agent model, to which neural net and positive Reinforcement agents are attached. Assessment comprises Pre-training (prior to usage of AI Gaming Systems) and post- The computers offer a context-free environment in which many people with autism feel comfortable, therapists and teachers are increasingly using virtual reality tools to teach life skills, such as crossing the road. Teacher, therapists use this virtual system, to develop the abilities of children (social interaction, cognitive processes, vocabulary, attention).[2]

Main attributes of the program are:

- Adaptable for local languages and local problems
- Including emotional therapy
- Developing social and communication barriers
- Rehabilitation at home
- Cost effective
- Artificial Intelligence based
- Resource setting

4. Summary

The paper provided a short but broad summary about application of artificial intelligence using cognitive psychology. The list of these application are not complete, because these research field is a dynamic changing area, and the fusion of the two sciences (cognitive psychology, and artificial intelligence) will provide amazing research fields. Mental modelling and Human Computing Interaction are leading research fields also in the cognitive psychology.

Emotion recognition and cognitive robotics were not mentioned in this paper, but re also an important part of the shown field.

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