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Person responsible for CD-ROM Proceedings:
Łukasz Piątek
(+48 17) 866 1191
E-mail: LPiatek@wsiz.rzeszow.pl

HSI 2010 Conference Programme

	1st Conference room	2nd Conference room
	May 13, 2010	
8:00-8:15	**Opening ceremony**	
8:15-9:00	**Keynote lecture: Prof. Ryszard Tadeusiewicz "*Speech in Human System Interaction*"**	
9:00-9:30	**Coffee break**	
9:30-12:30	**Artificial Intelligence**	**Special Session: *Accessing, Structuring, Analyzing and Adapting Information in Web 2.0***
09:30	Adam Grzech and Agnieszka Prusiewicz. *Services Merging and Splitting in Systems Based on Service Oriented Architecture Paradigm*	Giuseppe Russo, Arianna Pipitone and Roberto Pirrone. *Semantic Sense Extraction From Wikipedia Pages*
09:45	Andrzej Pulka and Adam Milik. *Hardware model of commonsense reasoning based on Fuzzy Default Logic*	Antonina Dattolo, Felice Ferrara and Carlo Tasso. *The role of tags for recommendations*
10:00	Alexander Rotshtein and Hanna Rakytyanska. *Multiple-Inputs Multiple-Outputs Object Identification based on Fuzzy Relations and Genetic Algorithm*	Aravind Chandramouli, Susan Gauch and Joshua Eno. *A popularity-based URL ordering algorithm for crawlers*
10:15	Ciprian-Radu Rad, Milos Manic, Radu Balan and Sergiu-Dan Stan. *Real time evaluation of inverse kinematics for a 3-RPS medical parallel robot usind dSpace platform*	Angelo Di Iorio, Alberto Musetti, Silvio Peroni and Fabio Vitali. *Crowdsourcing semantic content: a model and two applications*
10:30	Jan Andreasik, Andrzej Ciebiera and Sławomir Umpirowicz. *ControlSem – distributed decision support system based on Semantic Web technologies for the analysis of the medical procedures*	Mirco Speretta, Susan Gauch and Praveen Lakkaraju. *Using CiteSeer to Analyze Trends in the ACM's Computing Classification System*
10:45	Bohdan Kozarzewski. *A Neural Network Based Time Series Forecasting System*	Luca Mazzola, Davide Eynard and Riccardo Mazza. *GVIS: a framework for graphical mashups of heterogeneous sources to support data interpretation*
		Special Session: *Human System Interaction and Wireless Sensor Networks*
11:00	Tiberiu Alexandru Antal and Adalbert Antal. *The use of genetic algorithms for the design of mechatronic transmissions with improved operating conditions*	Daniele Alessandrelli, Paolo Pagano, Christian Nastasi, Matteo Petracca and Aldo Franco Dragoni. *MIRTES: MIddleware for Real-time Transactions in Embedded Systems*
11:15	Yewei Tao and Xia Sun. *A Biometric Identification System Based on Heart Sound Signal*	Philipp Gorski, Frank Golatowski, Ralf Behnke, Christian Fabian, Kerstin Thurow and Dirk Timmermann. *Wireless Sensor Networks in Life Science Applications*
11:30	Andrzej Burda and Zdzisław S. Hippe. *Uncertain Data Modeling: The Case of Small and Medium Enterprises*	Orazio Mirabella, Michele Brischetto and Giuseppe Mastroeni. *MEMS based Gesture Recognition*
11:45	Yajun Wang and Qiunan Meng. *Application of CBR for Activity-Based Cost Estimation in Steel Enterprises*	Pablo Lopez-Matencio, Javier Vales-Alonso, Francisco J. González-Castaño, Jose L. Sieiro-Lomba and Juan J. Alcaraz-Espin. *Ambient Intelligence Assistant for Running Sports Based on k-NN Classifiers*
12:00	Shuyun Jia and Jiang Chang. *Design and implementation of MAS in renewable energy power generation system*	Giancarlo Iannizzotto, Francesco La Rosa and Lucia Lo Bello. *A wireless sensor network for distributed autonomous traffic monitoring*
12:15	GuoQing Yin and Dietmar Bruckner. *Daily Activity Learning from Motion Detector Data for Ambient Assisted Living*	
12:30-13:30	**Lunch**	
13:30-15:45	**Artificial Intelligence**	**Special Session: *HSI for Monitoring Elders and Disabled at Home***
13:30	Zbigniew Szymański and Marek Dwulit. *Improved nearest neighbor classifier based on local space inversion*	Tomasz Kocejko, Jerzy Wtorek, Adam Bujnowski, Jacek Ruminski, Mariusz Kaczmarek and Artur Polinski. *Authentication for elders and disabled using eye tracking*
13:45	Kevin McCarty, Milos Manic and Shane Cherry. *A Temporal-Spatial Data Fusion Architecture for Monitoring Complex Systems*	Jacek Rumiński, Jerzy Wtorek, Joanna Rumińska, Mariusz Kaczmarek, Adam Bujnowski, Tomasz Kocejko and Artur Poliński. *Color transformation methods for dichromats*
14:00	Szymon Chojnacki. *Optimization of Tag Recommender Systems in a Real Life Setting*	Piotr Augustyniak. *Complementary application of house-embedded and wearable infrastructures for health monitoring*
14:15	Mircea Coman, Sergiu-Dan Stan, Milos Manic and Radu Bălan. *Application of distance measuring with Matlab/Simulink*	Adam Bujnowski, Jerzy Wtorek, Mariusz Kaczmarek, Tomasz Kocejko and Jacek Rumiński. *Estimation of activity parameters by means of domestic media consumption analysis*
14:30	Ersin Kaya, Bulent Oran and Ahmet Arsalan. *A Rough Sets Approach for Diagnostic M-Mode Evaluation in Newborn with Congenital Heart Diseases*	Andrzej Sluzek and Mariusz Paradowski. *A Vision-based Technique for Assisting Visually Impaired People and Autonomous Agents*
14:45	Mehmet Hacibeyoglu and Ahmet Arsalan. *Reinforcement Learning Accelerated with Artificial Neural Network for Maze and Search Problems*	Jerzy Wtorek, Adam Bujnowski and Magdalena Lewandowska. *Simultaneous monitoring of heart performance and respiration activity*
15:00	Karol Przystalski, Leszek Nowak, Maciej Ogorzałek and Grzegorz Surówka. *Semantic Analysis of Skin Lesions Using Radial Basis Function Neural Networks*	
15:15	Radu-Emil Precup, Sergiu Viorel Spataru, Mircea-Bogdan Radac, Emil Petriu, Stefan Preitl and Claudia-Adina Dragos. *Model-based Fuzzy Control Solutions for a Laboratory Antilock Braking System*	
15:30	Izabela Rejer. *How to Secure a High Quality of an Expert Fuzzy Model*	
15:45-16:00	**Coffee break**	
16:00-17:30	**Telemedicine and e-Health**	**Special Session: *Designing Scada Systems in Industry (DESSI)***
16:00	Francesco Cardile, Giancarlo Iannizzotto and Francesco La Rosa. *A Vision-Based System for Elderly Patients Monitoring*	Igor Nai Fovino, Marcelo Masera, Luca Guidi and Giorgio Carpi. *An Experimental Platform for Assessing SCADA Vulnerabilities and Countermeasures in Power Plants*
16:15	Marek Jaszuk, Grażyna Szostek and Andrzej Walczak. *Ontology Building System for Structuring Medical Diagnostic Knowledge*	Salvatore Cavalieri, Giovanni Cutuli and Salvatore Monteleone. *Evaluating Performance of OPC UA Communication*
16:30	Elena Zaitseva. *Reliability Analysis Methods for Healthcare system*	Pere Ponsa, Ramon Vilanova, Alex Perez and Bojan Andonovski. *SCADA Design in Automation Systems*
16:45	Takumi Kato, Noppadol Maneerat, Ruttikorn Varakulsiripunth, Satoru Izumi, Hideyuki Takahashi, Takuo Suganuma, Kaoru Takahashi, Yasushi Kato and Norio Shiratori. *Provision of Thai herbal recommendation based on an ontology*	Jacek Pieniążek. *Adaptation of the display dynamics for monitoring of controlled dynamical processes*
17:00	Thomas Maier, Thomas Meschede, Gero Strauss, Tobias Kraus, Andreas Dietz and Tim C. Lüth. *Joystick Control with Capacitive Release Switch for a Microsurgical Telemanipulator*	**Workshop on Cognitive Sensor Fusion:** Gines Benet, José E. Simó, Gabriela Andreu-García, Juan Rosell and Jordi Sánchez. *Embedded Low-Level Video Processing for Surveillance Purposes*
17:15	Alice Ravarelli and Roberto Pazzaglia. *Analyzing Text Comprehension Deficits in Autism with Eye Tracking: A Case Study*	
18:00	**Departure to Conference Welcome Party - Campus in Kielnarowa**	
18:30-21:00	**Conference Welcome Party - Campus in Kielnarowa**	

HSI 2010 Conference Programme

	1st Conference room	2nd Conference room
	May 14, 2010	
8:00-9:30	**Keynote lectures: Dr. Yasuhiro Ota *"Toyota Partner Robots - From Development to Business Implementation"*, Prof. Paweł Strumiłło *"Electronic Interfaces Aiding the Visually Impaired in Environmental Access, Mobility and Navigation"***	
9:30-10:00	**Coffee break**	
10:00-13:00	**Human-Centered Design**	**Human Machine Interaction**
10:00	Ivo Maly, Zdenek Mikovec and Jan Vystrcil. *Interactive Analytical Tool for Usability Analysis of Mobile Indoor Navigation Application*	Akinori Sasaki, Hiroshi Hashimoto, Sho Yokota and Yasuhiro Ohyama. *Image-Based Finger Pose Measurement for Hand User Interface*
10:15	Rita Wong, Norman Poh, Josef Kittler and David Frohlich. *Towards Inclusive Design in Mobile Biometry*	Yasin Guven and Duygun Erol Barkana. *Bone Cutting Trajectory Generation using a Medical User Interface of an Orthopedical Surgical Robotic System*
10:30	Avid Roman Gonzalez. *System of Communication and Control Based on the Thought*	Krzysztof Skabek, Marek Francki and Ryszard Winiarczyk. *Implementation of the View-Dependent Progressive Meshes for Virtual Museum*
10:45	Junko Ichino, Tomohiro Makita, Shun'ichi Tano and Tomonori Hashiyama. *Support for Seamless Linkage between Less Detailed and More Detailed Representations for Comic Design*	Daisuke Chugo, Hajime Ozaki, Sho Yokota and Kunikatsu Takase. *Seating Assistance Control for a Rehabilitation Robotic Walker*
11:00	Marco Porta and Alice Ravarelli. *Eye-Based User Interfaces: Some Recent Projects*	Peter Nauth. *A Method for Goal Understanding and Self Generating Will for Humanoid Robots*
11:15	Ding-Hau Huang and Wen-Ko Chiou. *The effect of using visual information aids on learning performance during large scale procedural task*	Tomasz Zabinski and Tomasz Mączka. *Human System Interface for Manufacturing Control - Industrial Implementation*
11:30	Ersin Karaman, Yasemin ÇETI.N and Yasemin Yardimci. *Angle Perception on Autostereoscopic Displays*	Ryo Saegusa. *Visuomotor coherence based robot hand discovery*
11:45	Wen-Ko Chiou, Ming-Hsu Wang and Chien-Yu Peng. *Landmark effect in digital human model simulation tasks by using the biomorphic tool*	Stefan Sieklicki, Wiktor Sieklicki and Marek Kościuk. *Mobile wireless measurement system for potatoes storage management*
12:00	Pawel Rozycki and Janusz Korniak. *The influence of the control plane mechanisms on the quality of services offered by the GMPLSnetwork*	Leon Palafox and Hideki Hashimoto. *Human Action Recognition using 4W1H and Particle Swarm Optimization Clustering*
12:15		
12:30-13:30	**Lunch**	
13:30-15:00	**Cyber Security**	**Special Session: *Modeling the Mind***
13:30	Teresa Mendyk-Krajewska and Zygmunt Mazur. *Problem of Network Security Threats*	Heimo Zeilinger, Andreas Perner and Stefan Kohlhauser. *Bionically Inspired Information Representation Module*
13:45	Igor Ruiz-Agundez, Yoseba K. Penya and Pablo García Bringas. *Optimal Bayesian Network design for efficient Intrusion Detection*	Roland Lang, Stefan Kohlhauser, Gerhard Zucker and Tobias Deutsch. *Integrating Internal Performance Measures into the Decision Making Process of Autonomous Agents*
14:00	Zhi-Ming Yao, Xu Zhou, Er-Dong Lin, Su Xu and Yi-Ning Sun. *A Novel Biometric Recognition System based on Ground Reaction Force Measurements of Continuous Gait*	Dietmar Dietrich, Roland Lang, Dietmar Bruckner, Georg Fodor and Brit Müller. *Limitations, Possibilities and Implications of Brain-Computer Interfaces*
		Special Session: *Human Sensory Factors and Their Applications*
14:15	Ivan Enrici, Mario Ancilli and Antonio Lioy. *A Psychological Approach to Information Technology Security*	Mitsuki Kitani, Tatsuya Hara, Hiroki Hanada and Hideyuki Sawada. *A taking robot for the vocal communication by the mimicry of human voice*
14:30		Sho Yokota, Hiroshi Hashimoto, Yasuhiro Ohyama, Jin-Hua She, Daisuke Chugo and Hisato Kobayashi. *Classification of Body Motion for Human Body Motion Interface*
14:45		Seiji Hata, Daisuke Nakatani and Junichiro Hayashi. *Detection of Buildings in Observing Images Using Map Information*
15:00-15:30	**Coffee break, arrangement of poster session**	
15:30-17:00	**Poster Session will perform in the upper stair case. All Authors are kindly requested to be present in vicinity of their posters**	**Workshop on Cognitive Sensor Fusion:** Dietmar Bruckner and Gerhard Zucker
17:30	**Departure to Gala Dinner - Lancut Castle**	
18:00-22:00	**Gala Dinner - Lancut Castle**	
	May 15, 2010	
8:30-9:15	**Keynote lecture: Prof. Hideyuki Sawada *"Displaying Tactile Sensations and the Perspectives of Multimodal Interface"***	
09:30-11:00	**Education and Training**	**Special Session: *Computational Intelligence in Human Activity***
09:30	Leonidas Deligiannidis and Erik Noyes. *Visualizing Creative Destruction in Entrepreneurship Education*	Krzysztof Pancerz and Zofia Matusiewicz. *Prediction with Temporal Rough Set Flow Graphs: the Eigen Fuzzy Sets Perspective*
09:45	Joanna Marnik, Sławomir Samolej, Tomasz Kapuściński, Mariusz Oszust, Marian Wysocki, Piotr Szczerba and Przemysław Ogorzałek. *Computer Vision and Graphics Based System for Interaction with Mentally and Physically Disabled Children*	Thierry Luhandjula, Karim Djouani, Yskandar Hamam, Ben van Wyk and Quentin Williams. *A hand-based visual intent recognition algorithm for wheelchair motion*
10:00	Katarzyna Harężlak and Aleksandra Werner. *Extension of the MOODLE e-learning platform with database management mechanisms*	Edy Portmann, Aliaksei Andrushevich, Rolf Kistler and Alexander Klapproth. *Prometheus - Fuzzy Information Retrieval for Semantic Homes and Environments*
10:15	Claudia-Adina Dragos, Stefan Preitl, Radu-Emil Precup and Emil M. Petriu. *Magnetic Levitation System Laboratory-based Education in Control Engineering*	Jerzy Gomuła, Wiesław Paja, Krzysztof Pancerz and Jarosław Szkoła. *A preliminary attempt to rules generation for mental disorders*
10:30	Cagin Kazimoglu, Mary Kiernan and Elizabeth Bacon. *Enchanting E-learning through the use of interactive-feedback loop in digital games*	
11:00	**Closing of the 3rd Human System Interaction Conference**	
12:00-13:00	**Lunch**	

Bionically Inspired Information Representation Module

Heimo Zeilinger *Member, IEEE,* Andreas Perner *Member, IEEE,* Stefan Kohlhauser,
Vienna University of Technology
[zeilinger,perner,kohlhauser]@ict.tuwien.ac.at

***Abstract*—In artificial intelligence, various theories on knowledge representation have gained ground. While logic descriptions, semantic nets, frames and associative networks are used for the implementation, the question which theory is best to be used as archetype for the knowledge model is controversially discussed. Regarding the use of biological principals, neural nets and psychological inspired theories are applied to technical concepts. Both approaches show disadvantages regarding their engineering usage. This article presents an information representation module that is developed for a psychoanalytical inspired reasoning unit. The module and its advantages in contrast to other approaches are discussed and tested in a game of artificial life. Defined data structures and the psychoanalytic background are explained. A use case is shown which helps to understand the principals behind the model.**

***Index Terms*—knowledge representation, software agent, artificial intelligence, psychoanalysis, bionics**

I. Introduction

THe Artificial Recognition System (ARS) project, introduced at the Vienna University of Technology in 2003, aims to open a new chapter in artificial intelligence by the introduction of psychoanalytic principals to computer science [1]. ARS originates in building automation, where a demand to provide control systems, which are able to cope with a growing amount of data, is given. Along the quality to deal with an increasing amount of data, the functionality to handle unknown situations is an additional desired benefit. A system that is perfectly able to deal with these requirements is the human being, respectively the human psyche. It is able to abstract and create new action-plans for newly appeared circumstances. Hence, the ARS project uses the human psyche as archetype for modeling a decision unit for automation control systems [2]. In doing so a new concept that bases on the neuropsychoanalytical approach is introduced. The designed model is verified in autonomous embodied software agents. Project ARS forms a promising step towards new approaches of designing automatic reasoning systems for automation applications. The choice of neuropsychoanalysis as archetype for the development of a decision unit offers new perspectives for the research field.

A. The ARS Approach and Psychoanalysis

Up to now, approaches in artificial intelligence provide successful functionality for a restricted and precise defined environment. However, for the use in highly dynamic environments, no adequate solution has been found yet. The ARS project handles this problem in a new way. For building a model of the decision unit know-how from psychoanalysis is used. In particular Sigmund Freud's second topographical model that provides a functional description of the human mind [3] is examined. Regarding this methodology embodiment has to be included in the model [4]. This point of view matches with [5], [6] [pp. 161-164].

It is the aim of the ARS-project, to implement functionality and not to copy observed behavior only. Projects like the development of the Kismet robot [7] at the Massachusetts Institute of Technology are based on copying aspects of the human behavior. In particular, this robot shows facial expressions similar to a human being, although the robot does not imply any of the human beings psychic functions like feelings, demands or consciousness [8]. Human behavior is just projected by the person watching the robot. The ARS project goes another way. It is assumed to be possible to integrate human mind functionality based on psychoanalytic theory [8].

To distinguish between behavior and functionality, the right model has to be chosen [9]. Another question is how to define the functionality in a technical point of view. This is handled in the ARS project by the use of the top-down design approach. From our point of view, it is the wrong way to form complex functionalities like human psychic processes by imitating brain processes at the neural-abstraction layer. First these processes are not fully investigated and their mapping to mind processes are controversially discussed. Like stated in [8], the top-down approach starts at the topmost layer (the main functionality). This level is divided into sub-functionality, till an abstraction level is reached, which contains technical implementable parts.

The topmost functionality is based on the three instances Id, Ego and Super-Ego according to the second topographical model of the human mind [3]. These three modules are split up into smaller functional parts, resulting in the ARS model. A detailed description can be found in [4] and [10]. Generally spoken, the Ego is mainly responsible for planning and mapping internal demands to their realization in the agents environment. The Id is the source of internal demands that are triggered by the bodily state. The Super Ego defines a set of rules that depend on the social environment. In technical terms, these rules are described as safety critical restrictions.

B. Saving Information and Actions

This paper focuses on the information-representation structure for the ARS model. It is described how information is stored, retrieved and connected. As the information is processed in a psychoanalytical inspired decision unit, the information representation has to follow the psychoanalytic concepts too. The scientific challenge is to develop an appropriate solution that fits the ARS approach.

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Section II outlines state of the art developments for information representation. A detailed description of the model structure can be found in Section III. An explanation of the data-types is given in Section III-B while their implementation is described in Section IV. To test the system and verify the results, an artificial game of life is used, where software agents, which contain the ARS decision unit, have to fulfill several use cases. The Bubble World simulator (BWsim) is explained in detail in Section V. In Section VI the implementation is discussed by a proposed use case.

II. State of the Art

In the area of artificial intelligence the question of how to represent and store information is fundamental. A common approach is to get inspiration from human sciences for the design of knowledge bases. An implication that can be principally agreed with. Regarding autonomous agents and robots, the differentiation of the information type in declarative and procedural memory or its sustainability in the human mind, like short-term and long-term memory, is a commonly used. Ho et al. [11] and Tecuchi et al. [12] implement an episodic memory, inspired by the work of Tulving [13] and Baddely [14] to their software agents. Anderson et al. [15] introduces a production system into the cognitive architecture ACT-R that is based upon a clear distinction between declarative and procedural memory. A pre-version of the actual ARS model has been designed with modules that imply the differentiation of semantic, episodic and working memories.

The crux of the matter in the division to types of information and memory systems is stated from different sides. Pfeifer et al. criticize in [6] that human sciences define more than two to three types of memory. For engineers, memory types like the episodic or semantic one seem to be important at first sight. The question is, if the model of memory misses a part in case several parts are ignored. Newel et al. [16] left out this differentiation in his cognitive architecture SOAR (State Operator Apply Result). Newel states that as SOAR is claimed to be a cognitive architecture different memory effects emerge without an individual implementation of memory structures. He explains and claims his view in [16]. In addition different memory systems are based upon different structures and functionalities that are generally fragmentary defined. This instance seems to make the theory unfeasible for the use in engineering terms as the structure itself is a very important point for the construction of a knowledge base. On the other hand, engineers use this space of freedom in order to form an own interpretation of structures and functionalities. This brings up another point of criticism that is to say that engineers transfer models of human sciences to the area of engineering without the required expertise. A mistake that is admitted in the ARS project where interdisciplinary work with experts from neuropsychoanalysis and psychoanalysis is done.

Bovet et al. goes a different way as they do not assume different memory systems but an identical structure based on the interconnection of sensor and motor modalities [17]. As Pfeifer, he holds the view that memory emerges out of the interaction with the environment and the correlation between senor stimuli and motor activity. In AMOUSE, Bovet et al. implement their view. Beneath the sensor-motor-connective approach, knowledge is stored in autonomous agents on the base of first-order logics and enhancements of first order logics, semantic nets or frames, respectively script technologies. The first-order logic approach is generally criticized as it is doubted to describe the whole world by logic relations. Frames and neural nets are said to leave too much to chance; the required behavior will not emerge. Production systems like SOAR are based on a combination of both approaches.

The ARS model bases on a hierarchical view of sensor data fusion [18], [19]. The manipulation of the received semantic symbols takes place in a psychoanalytic inspired decision unit. The information storage is done within a module that is fully decoupled from the reasoning unit on a parallel information representation layer. This module as well as the psychoanalytic theory, which it bases on, is discussed below.

III. Information Representation System

Regarding the design of the ARS decision unit, it has to be differentiated between the modeling and the implementation part. Section III-A and III-B deal with the modeling process while Section IV focuses on the implementation.

A. Assumptions

The modeling process is realized by the translation and adaptation of psychoanalytic terms to the area of engineering. This is done in interdisciplinary work with psychoanalysts. A control system based upon Sigmund Freud's second topological model of the human mind is specified. In [10], [8] the structure of the ARS model 4.0 is described in detail and an implementation to embodied software agents is shown. The article at hand focuses on the information structure that is manipulated by the decision unit. As the reasoning unit bases on psychoanalytic theory the information structure has to correspond to this theory too. In [20] three atomic data types are defined that are labeled as thing-presentations, word-presentations and affects. The definitions of these data-types are discussed in Section III-B.

The reasoning unit is responsible for the manipulation of semantic symbols in order to achieve decisions regarding upcoming actions. It receives data from the neuro-symbolic layer that turns sensory signals into symbols. The neuro-symbolic layer forms the sensor and actuator interface between the reasoning unit and the body. The neuro-symbolic network defines the fusion of raw sensor data to semantic symbols. It is discussed in [19] in detail. Fig. 1 shows the information flow through the reasoning unit. The input is formed by environmental and bodily sensory data (see arrow 1). The ARS model additionally specifies an internal system balance called homeostasis. The homeostatic output defines the third type of input to the decision unit. It recognizes bodily status levels that are out of balance. Regarding the human being, homeostatic levels are blood consistences or hormone levels. Mapped to a technical system this accords to e.g. an energy level.

The system input is processed within the sensor interface to multimodal-symbols. Multi-modal symbols are neuro-symbols

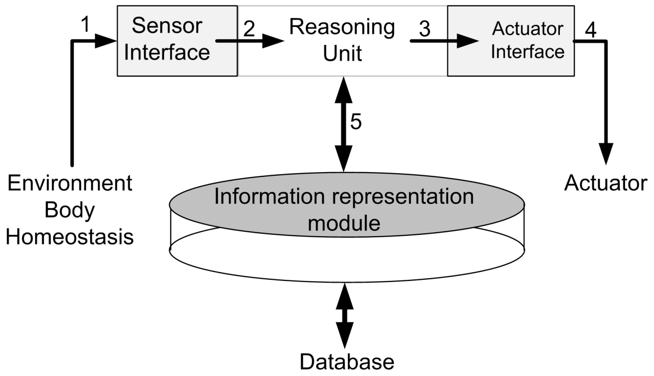

Fig. 1. Information flow through the reasoning unit

that merge information on multi sensor modalities. As a result, the reasoning unit receives a neuro-symbolic representation of the environment and the bodily and homeostatic state (see arrow 2 in Fig. 1). Out of this fact assumptions for the development of the information representation module are formed.

- The reasoning unit receives information on the environment in the form of semantic symbols. Each symbol represents at least the sensor modality of one object – e.g. its visual representation. At the lowest granularity, a symbol represents the object itself.
- Symbols are definitely assigned to received objects. The binding between sensor data that belong together is already done in the sensor interface.

As shown in Fig. 1, the information is manipulated by the reasoning unit and transferred to the actuator interface (see arrow 3). There, it is transformed to signals that control the system's actuators (see arrow 4). In between arrow 5 shows the information exchange between the reasoning unit and the information representation module that retrieves and stores information in a database. This module is discussed in detail in Section III-B. The information representation system is designed to operate only in composition with the ARS 4.0 model but functionally decoupled from it.

- It is strictly differentiated between information and control flow. The proposed data structures are manipulated by the reasoning unit and required to control the system. However, they do not define the search algorithms that are required to operate in the search space and provide data structures for the reasoning unit. These control functionalities are part of the information representation module's functionality.
- The information representation module must not be mistaken for a memory system. It is a structure related to storing and retrieving data following the psychoanalytic defaults. Contrariwise, the term memory implies functionality that is distributed to the whole control unit.
- The first version does not show learning abilities. It is focused on the search and retrieval of information. An adaption for specific learning mechanisms is arranged in further work.

B. Representation of Information

Below the definitions of the atomic data types and essential psychoanalytical nomenclature are given. The first terms discussed are primary and secondary process. They are modes that define the manipulation of data in the reasoning unit and specify certain encoding types of information. Every function in the reasoning unit operates by following one of these principals. Functions that follow the primary process do not filter any conflictive data. This means that one and the same process is able to manipulate contradicting information in parallel. Primary processes are not able to structure information regarding temporal or logical dependencies. On the contrary, functions that operate in the secondary process mode are able to form dependencies between information components. Logical, temporal and local relations are formed. Conflicts have to be solved. In [10] both types of processes are defined in detail. Data structures can only be manipulated by specific process modes. The three atomic data-types are defined in [20] and listed below.

Thing-presentations are formed by acoustic, visual, haptic, olfactory and taste modalities. They are not limited to single sensor modalities. A thing-presentation represents a combination of multiple sensor modalities. They form the sensor representation of a physical object but are not limited to it. Innate actions are represented by thing-presentations too. However, the whole action cannot be sub-divided to its basic components – e. g. muscle control. So it is represented as a single thing-presentation. The sensor interface (see Fig.1) provides this information. Multi-modal symbols are directly mapped to thing presentations. Within the implementation, temporally associated thing-presentations form a net that is labeled as thing-presentation mesh.

Word-presentations are represented by a set of signs. These signs are mapped to perceived data and set in context to each other. In case of human language, the alphabet or vocabularies represent a set of signs. One word-presentation merges a thing-presentation mesh to one sign. This sign is used for further processing. Contrary to thing-presentations, word-presentations introduce logic, temporal, and local relations. Word-presentations allow it to introduce scenarios and plans. Any information that is manipulated in the secondary process is formed out of word-presentations. They are formed in dependency to the environment. This means that the labeling of certain thing-presentation meshes with a word-presentation depends on the environment - e.g. the naming of objects depend on the language. Hence, the word-presentation that certain objects are labeled with, correspond between individuals. Contrary the thing-presentation meshes depend on the sensor system. Hence they are individually different as the sensor systems are individually different too. Two persons label a color with the same name even if there is no guarantee that the color is detected by person one the same way as it is done by person two.

The term affect has had to be adapted and could not be mapped directly to an engineering term. In psychoanalysis this term is used in diverse meanings with different unity. For the use in engineering terms, the affect represents the change of

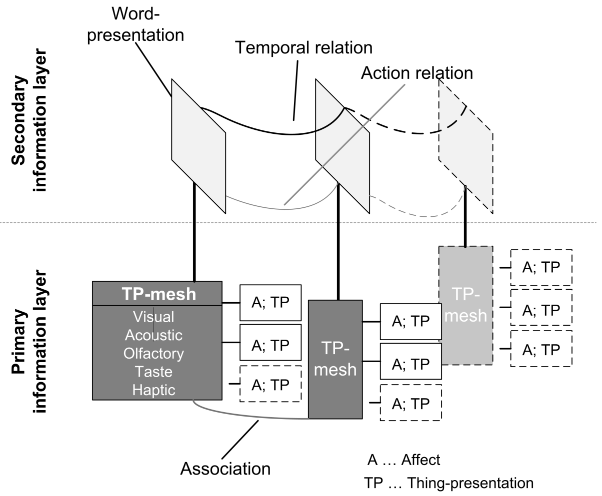

Fig. 2. Information representation structure

the homeostatic balance.

Regarding the different process and encoding modes, thing-presentations and affects are manipulated by primary processes, while word-presentations form the base for secondary processes. In [20] the activation of stored knowledge is discussed. It has been distinguished between outer and inner activation, which differentiates between activation by environmental and homeostatic information, and direct and indirect activation, which differentiates the activation by a direct match of incoming data or through a spread activation. Here, a closer look to the organization of information related to the context of scenarios is made. As it is shown in Fig.1 incoming information is manipulated by the reasoning unit. For this manipulation, several functions have to fall back to information about "experiences". This information is stored in a database. This database is loaded during runtime and managed by the information representation module. The methodology of dividing between control flow and information flow is taken from the modeling principal of the reasoning unit. Search algorithms and retrieval mechanisms are part of the module's management functionality. Fig. 2 shows the division between primary process information and secondary process information. These terms are directly mapped to the data structures regarding their manipulation in defined process modes. Thing-presentations, affects and their associations are represented in the primary information layer, while word-presentations are represented in the secondary information layer.

The primary information layer is arranged by thing-presentation meshes and appendices. In a first version, thing-presentation meshes represent only physical objects. Fig.2 shows an example of a thing-presentation mesh. The mesh exists out of single thing-presentations according to the sensed object's attributes. The appendices, which are formed by tuples, represent the object's influence on the agent. One component of the tuple is the affect, which is implemented as a value between minus one and one. The second component is a thing-presentation, respectively a thing-presentation mesh, which represents the action that has been applied to the object.

Thing-presentation meshes are associated with each other by corresponding attributes. This associations have a static weight in the first version of the module but vary in future implementations. If a thing-presentation mesh is "activated" by an information match, thing-presentation meshes of similar attributes are activated too. In order to limit the activation dispersion, association weights have to be established. The activated thing-presentation meshes are forwarded to the reasoning unit. The reasoning unit itself has to sort out important from unimportant information. On this layer, the associations do not include any logic relations. Thing-presentation meshes are connected with word-presentations (see Fig. 2). Here, temporal, local and logic relations are introduced. Word-presentations are combined to images. Relations between images form scenarios. These relations imply various components, like a temporal attribute or the action that has to be applied to an image. Scenarios are mapped to action plans. Even word-presentations are associated with each other, their thing-presentation meshes are not connected. Primary information layer and secondary information layer are coupled by the connection between thing-presentation meshes and word-presentations only. This connection is the link between perceived data and processed action plans.

The realization of the proposed data structures and the specified information representation module is discussed in Section IV.

IV. Implementation

In Section III the model of a psychoanalytical inspired information representation module is introduced. In this section the implementation of the information representation module and the defined data structures is discussed. First, an overview of the realization of the data structures is given.

Thing-presentation meshes are arranged in a frame structure. As shown in Fig. 3, the attributes of the frame are divided into four groups. First, the frame structure implements associations that associate single thing-presentations. These are the physical attributes of an object that is perceived by the sensor system. If there is a match between perceived information and a thing-presentation, associated thing-presentation meshes are activated too and forwarded to the reasoning unit. The more object information is available the more it is possible to limit the search space.

The second type of attributes contain tuples. One component is an association to actuator actions. These actions are applied to the object that is represented by a thing-presentation mesh. The other component is a value between minus one and one. According to the model in Section III this represents the affect and therefore defines an evaluation of the influence of an interaction with the object has had. A negative value represents a bad experience while a positive value represents a good one.

The third type concurs with weighted associations to other thing-presentation meshes. These associations are formed by local and temporal simultaneous appearance of thing-presentation meshes. These associative entities form images of situations.

The last attribute is the association to the word-presentation. Actually word-presentations are defined in the form of a basic

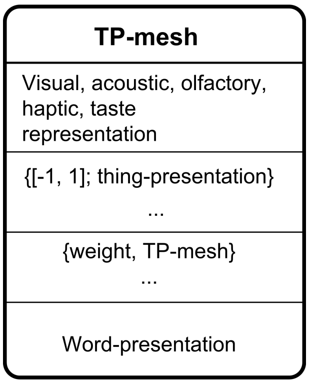

Fig. 3. Thing-presentation mesh

set of signs and logic relations. As the agents, in a first version, do not imply communication and learning abilities, these terms are hard-coded. This must be adapted in further work.

The secondary information layer is formed out of scenarios that are build upon word-presentations. They are connected to thing-presentations or represent logic relations that are not represented in the actual model. Psychoanalysis mentions that every word-presentation is connected to a thing-presentation. However, as logic relations are only connected in the secondary information layer, it does not make sense to define their representation at the primary information layer – regarding the engineering conversion only. Scenarios are implemented with semantic nets. The nodes are tuples of word-presentations that define an object. The relations in between define the logic and temporal dependency as well as the action that has to be applied to the current situation in order to execute the scenario.

Actually the search space is limited. This fact enables to search through the whole search space in every simulation step. An integration on more sophisticated search algorithms would meet the limits of the system performance in more complex scenarios. Hence, further work focuses on this issue.

V. Simulator

To test the described model, a game of artificial life – the Bubble World simulator (BWsim) – that is based on the MASON (Multi Agent Simulation of Neighborhoods) library [21] [22] is developed. Like outlined in Section I, embodied agents are defined and placed into the BWsim. Fig. 4 shows that the simulation environment contains several elements like walls, stones and basic energy-sources. A human-control-able agent is added in order to test the interaction between agents. By interaction with the artificial agent that is controlled by the ARS model, it is possible to trigger reactions and verify the system.

Fig. 4 illustrates a basic setup. The circles around the agent represent the vision area, separated into different sensor ranges and perspectives. The range and perspective specifies the level of detail with which an object is perceived. A factor that is important for the use cases proposed in Section VI.

It is a basic design goal of the simulator, to separate the simulation environment from the decision unit. The decision unit is decoupled from the simulator and can only receive/send

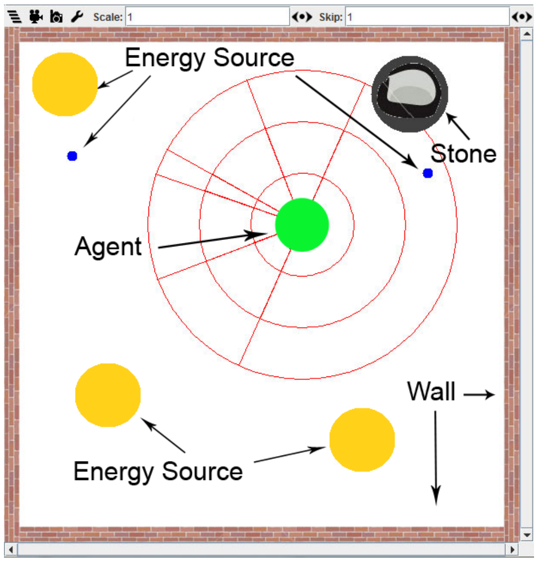

Fig. 4. Screenshot Bubble World Simulator

information through the defined interfaces. This prevents from using direct sensor-data instead of using their neurosymbolic representation. The agent perceives his environment through his sensors and the corresponding neurosymbolic values. In addition the modular composition of the BWsim, enables to outsource it to distributed hardware. The decisions for each artificial agent as well as their bodies and the simulation environment can be calculated on different CPUs. This can be realized only in case the interfaces between are defined and used.

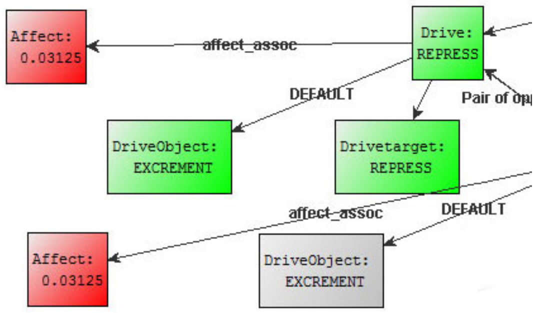

Fig. 5. Screenshot Inspector

To compare the research-results, different decision units are used in the proposed simulator. Until now, we are able to compare the psychoanalytical model against an implementation of the Fungus-Eater scenario [23] that is based on a static rule-set. Further work focuses on an implementation of a Believe-Desire-Intention (BDI) model and am realization of cognitive architectures like ACT-R and SOAR. The decoupling between the simulation environment and the decision unit ensures to exchange the different systems among each another.

Like discussed in Pfeier et al. [6] [pp. 161-164], embodiment is a precondition for intelligence. Furthermore the developed model is based on psychoanalysis, which implies the use of an embodied agent. The agents are equipped with actuators for executing their abilities (graping/carrying objects, consuming energy sources). Through sensors that contain visual, tactile and olfactory modalities, the agents are able to perceive their environment. Within the two dimensional environment the agents have the possibility to turn left/right and to move forward/backward. To simulate physical effects like hitting other objects, an additional physics engine for the MASON toolkit is used (http://cs.gmu.edu/~eclab/projects/mason/extensions/physics2d/, December 2009). The agent consumes energy, comparable to the energy consumption of the human body. Each action requires a specific amount of energy. Internal body systems are defined that simulate a homeostasis and define the body state (stomach tension, health, temperature, stomach content, ...). A detailed discussion can be found in [24]. Depending on the internal energy level, the decision unit decides for required actions and action plans (e.g. consume food or rest).

Like shown in Fig. 5, inspectors were defined to visualize the information flow within the model and to alleviate the debugging process. The inspectors enable to examine the current state of the agent's body systems and the data that is actually processed in the decision unit.

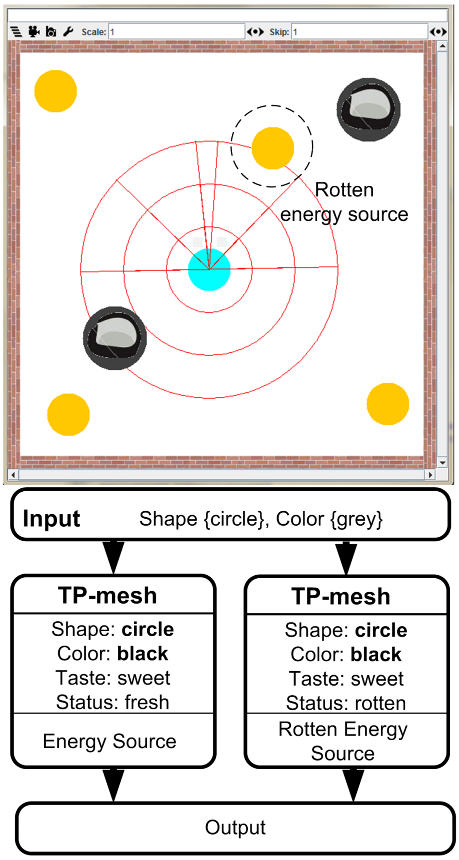

Fig. 6. Use case – part 1

VI. Results

Section V describes the simulation environment where the information representation module is tested. Autonomous software agents are placed in the Bubble World (BW). Their abilities are tested by specified use cases. The information representation module is developed for an interconnection with the ARS 4.0 reasoning unit. Hence its performance is evaluated in conjunction with the reasoning unit. Here a use case is presented. Even its task setting is simple, it is adequate to test and show the principal behind the proposed model and the way it works. More complex use cases are defined but not useful to present here as they would exceed this work. Further articles will deal with them in detail. In addition the presented use case shows the interplay between environmental and bodily stimuli in a well defined form. The configuration setup is composed out of one autonomous software agent, various energy sources and obstacles. Fig. 4 visualizes the scenario.

The agent runs out of energy from time to time and has to refill its levels by moving towards energy sources and consuming them. There exist two types of energy sources – a consumable and an uneatable one. If the agent is not eating it moves around within the environment. If the agent runs low on energy it searches for a consumable energy source in the environment. Through the vision sensors, the agent cannot differentiate the energy sources at first sight. The vision field is divided into areas that deliver details depending on the distance between the agent and the energy source. Fig. 6 shows an energy source in the outer field.

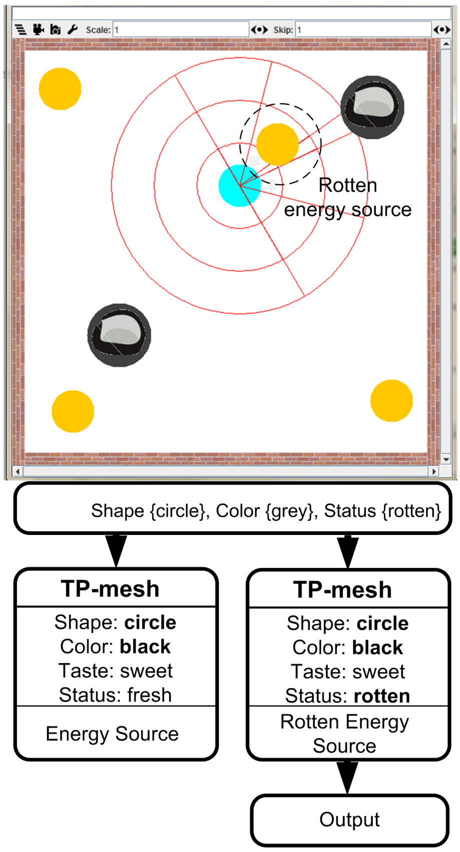

Fig. 7. Use case – part 2

The agent receives information on the shape and color of the object. This activates the thing-presentation meshes of both types of energy sources. They are forwarded to the decision unit. During the decision making process, scenarios that fit for both energy sources have to be found. A scenario that fits for the current task is to move towards the energy source in order to identify and eat it. This scenario is implemented by secondary information. After this scenario is selected the agent approaches the energy source. When the energy source is directly in front of it, it identifies that the energy source is rotten (see Fig. 7). Hence, only one thing-presentation mesh is selected. It is the one that contains an attribute to a rotten appearance. Actually these attributes are handled through visual appearance. In the future attributes have to be defined by additional sensor modalities like olfactory sensor modality in case of a rotten object.

VII. Conclusion

The article at hand discusses a psychoanalytical inspired information representation module. The defined data structures are differentiated by their encoding type to primary information and secondary information. Regarding this approach the information is divided by its abstraction level. Primary information is represented by semantic symbols that emerge out of sensor data, while secondary information binds meshes of semantic symbols to signs. These signs form the base in order to set information in logic context to each other. As a result, scenarios and action plans are build. The information representation module coupled to the ARS decision unit and integrated to an autonomous agent. It holds knowledge on experiences and rules that are feasible for an accurate decision making process. As the reasoning unit and the information representation concept rely to the neuropsychoanalytical approach, conflicts and contradictions regarding their realization can be reduced to a minimum.

Future work focuses on the implementation of improved search algorithms in order to handle search space of frames and semantic nets. In addition an advanced implementation of the secondary information layer, respectively word-presentations is done. Moreover, interaction between the autonomous software agents is established as well as path finding and localization tasks are integrated to more complex use cases. In addition the proposed model should be evaluated by integrating them to smart avatars – e.g. e-learning avatars. However, the concept is not limited to simulated agents but can also be applied to multi-agent areas like robotic and sensor network applications.

References

[1] D. Dietrich and G. Zucker, "New approach for controlling complex processes. an introduction to the 5th generation of AI," *Human System Interactions, 2008 Conference on*, pp. 12–17, 2008, invited keynote speech.

[2] D. Dietrich, G. Fodor, G. Zucker, and D. Bruckner, *Simulating the Mind - A Technical Neuropsychoanalytical Approach*. Springer, Wien, 2009.

[3] S. Freud, *Das Ich und das Es, Studienausgabe. Psychologie des Unbewußten*. Fischer Taschenbuch Verlag GmbH, 1975.

[4] H. Zeilinger, T. Deutsch, B. Muller, and R. Lang, "Bionic inspired decision making unit model for autonomous agents," in *Proc. IEEE International Conference on Computational Cybernetics ICCC 2008*, 27–29 Nov. 2008, pp. 259–264.

[5] M. Solms and O. Turnbull, *The Brain and the Inner World: An Introduction to the Neuroscience of Subjective Experience*. Karnac/Other Press, Cathy Miller Foreign Rights Agency, London, England, 2002.

[6] R. Pfeifer and J. Bongard, *How the body shapes the way we think*. MIT Press, 2007.

[7] C. Breazeal, *Designing Sociable Robots*. Cambridge, MA, USA: MIT Press, 2002.

[8] D. Dietrich, D. Bruckner, G. Zucker, B. Mller, and A. Tmej, "Psychoanalytical model for automation and robotics," *Proceedings of the 9th IEEE AFRICON 2009 (Technical keynote)*, vol. 1, 2009.

[9] S. Turkle, "Artificial intelligence and psychoanalysis: A new alliance," in *The Artificial Intelligence Debate: False Starts, Real Foundations*, S. R. Graubard, Ed. Cambridge, MA: MIT Press, 1989, pp. 241–268. [Online]. Available: http://web.mit.edu/sturkle/www/selecteditems.html

[10] R. Lang, "A decision unit for autonomous agents based on the theory of psychoanalysis," Ph.D. dissertation, Vienna Univesity of Technology, 2010.

[11] W. C. Ho, K. Dautenhahn, C. L. Nehaniv, and R. T. Boekhorst, "Sharing memories: An experimental investigation with multiple autonomous autobiographic agents," *IAS-8, 8th Conference on Intelligent Autonomous Systems*, pp. 361–370, 2004.

[12] D. Tecuci, "A generic episodic memory module," University of Texas at Austin, Tech. Rep., 2005.

[13] E. Tulving, *Elements of Episodic Memory*. Oxford: Clarendon Press, 1983.

[14] A. Baddeley, *Human Memory: Theory and Practice*. Psychology Press, 1997.

[15] J. R. Anderson, D. Bothell, M. D. Byrne, S. Douglass, C. Lebiere, and Y. Qin, "An integrated theory of the mind," *Psychological Review*, vol. 111, no. 4, pp. 1036–1060, 2004.

[16] A. Newell, *Unified Theories of Cognition*. Harvard Univ Press, 1994. [Online]. Available: http://books.google.at/books?id=1lbY14DmV2cC&printsec=frontcover&dq=Unified+Theories+of+Cognition

[17] S. Bovet and R. Pfeifer, "Emergence of delayed reward learning from sensorimotor coordination," *IEEE/RSJ International Conference on Intelligent Robots and Systems*, pp. pp. 2272–2277, 2005.

[18] W. Burgstaller, "Interpretation of situations in buildings," Ph.D. dissertation, Vienna University of Technology, Institute of Computer Technology, 2007.

[19] R. Velik, "A bionic model for human-like machine perception," Ph.D. dissertation, Vienna University of Technology, Institute of Computer Technology, 2008.

[20] H. Zeilinger, R. Lang, and B. Müller, "Bionic inspired information representation for autonomous agents," in *in press*, 2009.

[21] S. Luke, G. C. Balan, L. Panait, C. Cioffi-Revilla, and S. Paus, "Mason: A java multi-agent simulation library," *Proceedings of the Agent 2003 Conference*, 2003.

[22] S. Luke, C. Cioffi-Revilla, L. Panait, and K. Sullivan, "Mason: A new multi-agent simulation toolkit," in *Proceedings of the 2004 Swarmfest Workshop*, 2004.

[23] M. Toda, *Man, Robot and Society*. Martinus Nijhoff Publishing, 1982.

[24] T. Deutsch, T. Zia, R. Lang, and H. Zeilinger, "A simulation platform for cognitive agents," in *Proc. 6th IEEE International Conference on Industrial Informatics INDIN 2008*, 13–16 July 2008, pp. 1086–1091.