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# Communication Amoung Agents Using SACA Architecture

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***Abstract*—This paper deals the different cognitive architectures where in the existing cognitive architectures the following disadvantages are observed no communication between the agents. Individual agents will perform the task hence the performance will be slow when compared to agents performing in a group. In EM-One architecture there is communication between only two agents. In the proposed SACA architecture the main concentration is on the communication and coordination among the group of agents. The main advantage of the proposed is that it can be used in military applications. A highly motivated agent communicates with each other and hence increases performance.**

***Keywords*— Cognitive Science, Cognitive Architecture, Agent, Communication, Coordination.**

## I. INTRODUCTION

The marriage between the Freudian and the Turing revolutions was a unhappy marriage which resulted to the birth of cognitive science. Further, it was spiritual by the early development of mathematical theory of communication and cybernetics. It was first preceded in natural science of information. By 1930s, Sigmund Freud the revolutionary idea that most of the operation of mind is hidden in the layer of sub consciousness. The problem was that treatment for mental problems (psychoanalysis) had grown so based on guessing and void of empirical content that it began to be regarded as unscientific.

The scientific community was liberating from an erroneous notion to understand the working of mind and have sequence of conception undertaking the science with no business. This was the birth of behaviorism, between 1930 to 1950 in the predominant school of psychology. Before the turn of 20th century, Camillo Golgi and Santiago Raman y cajol works led to punctilious description of the structure of neuron and additionally the hypothesis that the neuron is the fundamental functional unit of the brain. Nobel Prize in Medicine in 1906. Infelicitously, neither Freud's nor skinner's adherents was not pellucid with the conception of cognitive function in neuron. Already in the tardy of artificial neural networks. John von Neumann one of the greatest scientific geniuses of 20th century he worked on the conceptual espousement between Turing work on formal theories of information that is the theory of neural science.

In a set of lectures in 1955 shortly afore his death, became the book The Computer & the Brain, Von Neumann (1958), suggested that the neurons in the interpreted as performing computation. The model is as follows: the brain receives information by sensing which can be given as the input data to the system. The brain takes the input data and process the data and engenders the results. The conception of this digital computation can be utilized as a framework for investigation that what transpires in between the input and output. This was missing in the behavioral theories which will focus only on replication and stimulus cognation. The brain according to this incipient model it has some concrete functionality like information processing which will affect stimulus to replication but it will be investigated in its own terms as computational process. This amalgamation of the theory of computation, conceptions an incipient research program for investigating what transpires in the ebony box of the mind that is rigorous and scientifically venerable. Noam Chomsky withal worked with Neumann in 20th century. In Chomsky published a review of Skinner's book Verbal Behavior which became the best book for itself. He outlined the major quandaries with behaviorism and made a compelling case for the paramount of studding the internal workings of cognition. Then together they published a book Syntactic Structure which revolutionized linguistics, became the last nail in the coffin of behaviorism, and opened the doors for cognitive science.

Chomsky's influence became more paramount for linguistics and empirical cognitive psychology, while Turing and von Neumann's work became central for the emergence of the field of computational cognitive science and artificial astuteness. [1]

Any cognitive architecture should satisfy three layers

1). Reflexive Layer: Reflex action is basically derived from human and animal biological neuromuscular action. The reflexes are built-in mechanisms where action can occur quickly, before thinking. In some cases, reflexes can be changed or overridden; a reflexive agent does not have any explicit motivational states like belief, desire, or intentions. For example, in the developed test bed, a reflexive agent can move in one of four directions (left, up, down, right) in response to the nature of the environment immediately in front of it; simply moving into free space and away from obstacles.

2). Reactive Layer: Reactive agent mechanisms, having more flexible control mechanisms, similar to the architecture described by Kaelbling (1986). This class of agent has extra perceptual pathways and mechanisms for integrating decision making, and behaviors across intended actions. For example, in the developed testbed, reactive agents can follow a specific goal. The goal is to identify the resource, move shortest way and collect any one or more resources.

3). Deliberative layer: Deliberative or BDI (Belief-Desire-Intention) agents build on the behaviors used in the reflexive and reactive agents. The deliberative actions are planned and coordinated in terms of the agent, its internal state, its motivations and its perception of resources in the environment. Mind is made of many small processes; these are called deliberative or mental agents. Each mental agent by itself can do some simple things. BDI (Beliefs, Desires Intentions) are the mental components present in rational agent architectures (Bratman, 1987; Cohen 1990; Rao and Georgeff, 1993). In the developed testbed, deliberative agents reasons about their own tasks and plans. Deliberative agents in a fungus world testbed are capable of performing different tasks. The deliberative agents can alter the reactive and reflective agents, from the reasons based on the Belief, Desire and Intention set.

## II. EXISTING COGNITIVE ARCHITECTURE

### A. *EM-ONE ARCHITECTURE*

EM-One architecture is for the reflective commonsense thinking which is able to think and reason it out. It reasons out by applying the "mental critics" . the word critics deal with the error its type and the various ways to eliminate the error and to learn by them. In EM-one relate to problems with the activity of the other critics. It is capable of reasoning of the common scence scenario that involves the interactions between the actors. Here we are giving an example of the building a table. The green and pink builds the table.

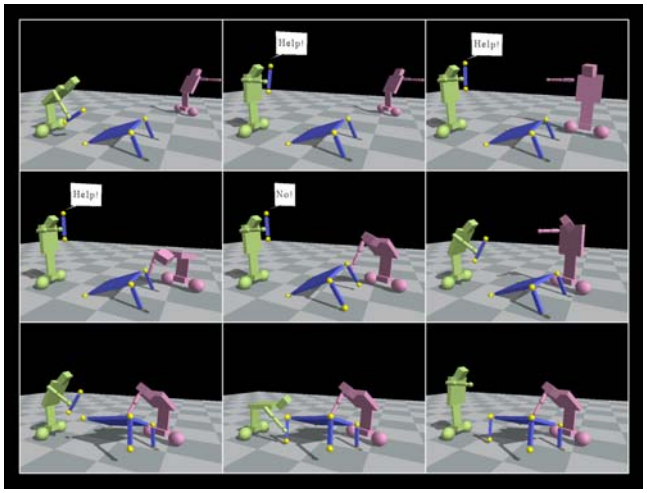


Fig1: Building a table together

Here, Green wants to build a table Green optically see that there isalready a partly built table and realizes that it requires to more legs to build thetable. Green goes over and places a stick, and then goes over to the table. Green try toattack the stick to the table but fails. Green expeditiously realizes that it requires avail to insert the leg under the table, because Green only has one arm. Green calls over to Pink. Pink, whohas been occupied with its own projects and has not been fixating on Green until now, visually examines Green holding a stick, and infers(mistakenly) that Green is to disassemble the partly built table. Pink comes over and commences to detach one of the table legs. Green realizes that Pink did not correctly infer Green's intent, and so attack.Green realizes that Pink did not optically holds Green and attack the table leg. Green attack to the stick again to the table, this time with Pink visually examining. Pink now realizes that Green doesn't want to disassemble the table, but rather wants to consummate the table, and that Green expects Pink to hold up the table so that Green can affix the table leg it isholding. Pink holds up the table, and Green inserts the table leg underneath.

This EM-one Architectiure is an architecture that supports the kinds of commonscense thinking that is been seen required to understand the above example. EM-One operates by using the mental critics principle . the mental critics solve the problems or the errors based on the common sense thinking.

A Six layer model of common sense

There are already 3 layers that are defined in the cognitive architecture called as the reflective,reactive and deliberative so in this six layerd architecture going to define the other three layer along with the previously defined layers called as there are three types of the self-reflective layers that act,reason out and as per that react and performs the action . These layers contain the mental critics that responds to the problems of the outside world. In the reactive layer it is filled with the reactive critics that suggest the soluction based on the goals and based on the outside world observation. The deliberative layer helps to reason out about the situation and what are the consequences that can happen based on the performed action by the reactive critics of the reactive layer. The reflective layer it take care of the inference process that occurs in the deliberative layers and this layer uses the reflective critics to access the effectiveness of the deliberation. The top layers are populates by the critics that can be used to access action and is based on the criteria and the actions must be consistent about its own model. The activity of all these critics is been managed by the meta managerial critics that select the subset of the critics based on the problem and the solving solution.

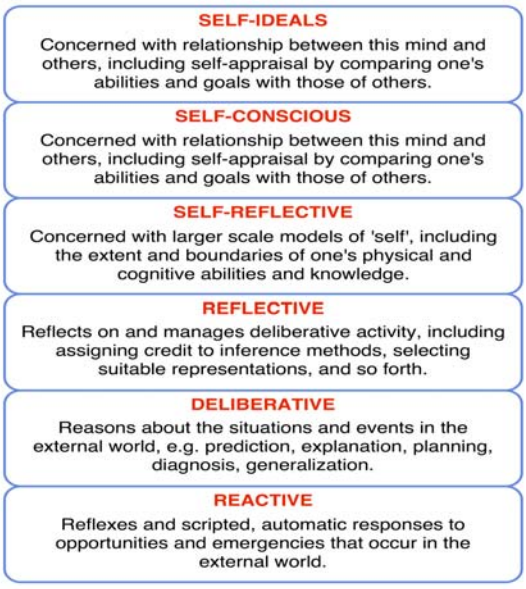


Fig2: A Six-Layer Model of Commonsense Thinking

EM-One supportsthe programming of reactive, deliberative, and reflective processes, it stores in the database of commonsense knowledge in the form of commonsense and uses it library of mental critics that apply this particular knowledge .these both they uses the common knowlegede or the stored knowledge to solve the problem. As already mentioned the EM-Ome has many Mental critics in each of the layers that is been discussed below:

Reactive Critics: the critics in this particular layer it reacts directly with the environment. This particular critics does action by recognizing a difference between the currently observed situation and the goal that is in practise

Deliberative Critics: this critcs represents the real world environment and the actions that are proposed by the reactive layer. These critics they operate based on the assumptions. They are used for the hypothesis that the does it performs the action that would help in achieving the goal or whether the assumtions is been consistent with the common sense critics .

Reflective critcs: these critics they operate on the tracking the recent action that represents the activity of the mind. It identifies the problem in the recent activities including the mistakes that are been made . they are capable of modifying the critics that make the mistakes so that it the mistakes are not been reperated. The deliberative layer uses the critics of the self-reflective,self conscious,and self ideal critics[8]

### *B. CRIBB*

This particular architecture was been developed based on the study of the children mind . it was been developed by Wahl and Apada . they developed a model called as the CRIBB that stands for the Children's Reasoning about Intentions,Beliefs, and Behaviour . it was been developed to investigate the reasoning of the young children. They conducted an experiment on the children to know whether the children between three to five years of age . in the experiment a child called maxi had put the chocolate inside the drawer and went later her mom took the chocolate and kept some where. The children who watched this were asked the question of wher will maxi come and search for the chocolate . the children above 5 didn't have any problem in having a correct guess or maxi a false belief where as the children below 5 will look for the chocolate where his mom has kept .

The cribb model consider about the physical state of the situation and about the other persons intension, beliefs and the behaviour. They obtain from its knowledges. The theory of mind can be seen further . where the inputs are perception, emotions . the agents belief that obtained by the perception. The agents belief are determined by the environment .the desire are determined by basic emotion, phyiology. These things they lead to the changes in the environment. And can change the agents emotions and as per the environment can change the perception.

The further is the description about the mechanism of the cribb architecture that defines the mechanism.

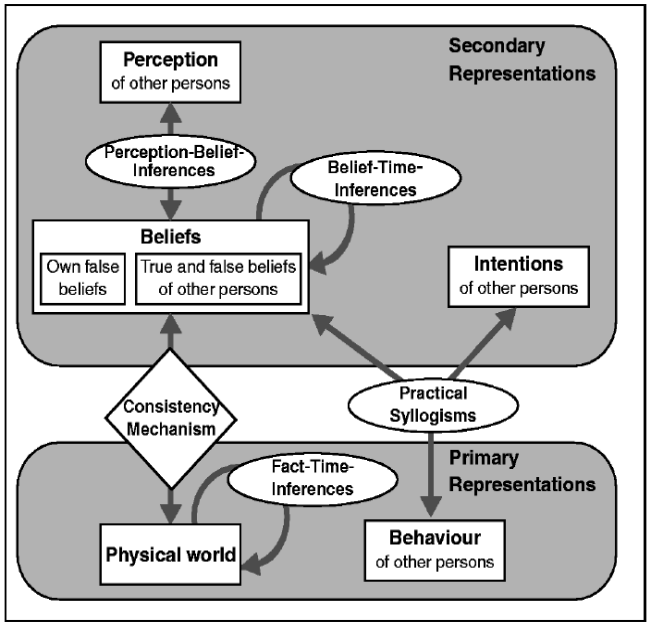


Fig3: High-Level View of CRIBB Architecture

This architecture it detects and it resolves any of the contradictions in the system. It is called each time when a new proposition is been added in order to know the consistency of the knowledge base. If something is found then it is been added to the knowledge base.

### C. *SMCA*

SMCA (Society of Mind Cognitive Architecture) tells about the the concept of mind which is a control system and it utilizes the "Society of Agents" metaphor. "Society of Agents" is a collective comportment of simple and keenly intellective agents. "Society of Mind" is an amassment of task-oriented and also it is deliberative agents; it is a puissant concept for mind research it can be benefited from the utilization of metacognition. The main aim is to develop a self configurable computational model which utilizes metacognition. It is a six tiered architecture. SMCA (Society of Mind Cognitive Architecture) control model is designed which mainly relies on a society of agents operating utilizing metrics which is associated with principles of artificial economics in the cognition of animals. This thesis investigates the metacognition as a puissant catalyst for control, coalesce and self-reflection. Metacognition will be utilized on all BDI models with veneration to orchestrating, reasoning, decision making, self reflection, quandary solving, learning and the general process of cognition to ameliorate performance.

One way on how to develop metacognition into SMCA model is based on the difference between metacognitive strategy, metacomponents or metacognitive aids. Metacognitive strategies are denoted activities like metacomphrension which is a remedial action and metamanagement that is self management and also the schema training which is full learning over cognitive structures. Metacomponents are aids for representing a thought. In order to develop an efficient, intelligent and optimal agent through the metacognition. It requires the

multiple layered control model that includes simple to complex of agent actions and their behaviours. This model has designed and it is implemented for six layers that includes reflexive, reactive, deliberative for BDI , learning that is Q-learner, metacontrol and metacognition layers.

Marvin Minsky proposed The Society of Mind theorem initially in the 1970s, at MIT's AI lab. Minsky, Papert and his students developed one of the first autonomous hand-eye robots. The hand-eye robot involved that the robot constructing building block structures. cameras were used to see, and a robotic hand to move. From this Minsky framed the term "Society of Mind." Minsky tells that, a mechanical hand, television eye, can build a block structures. to analyse this technology researchers took many years for the cognitive operations like seeing, grasping, and moving.

Minsky tells that, this development gives the conceptions for "Society of Mind" (Minsky, 1986). Minsky views astuteness as not just a simple or as an algorithm for cerebrating, but a cumulated gregarious activity of more specialized cognitive processes. According to him, that every mind is a "Society of Mind." The mind consists of a greater diversities of different mechanisms. Minsky proposes that the mind is a set of simple and more diminutive entities called micro-agents. Minsky tells can do simple work, connected with a sizably voluminous system called a society of agents. Each agent, having a variety of background, plays a different roles. The society of mind results from cumulating specialized cognitive processes. each agent is a simple code.

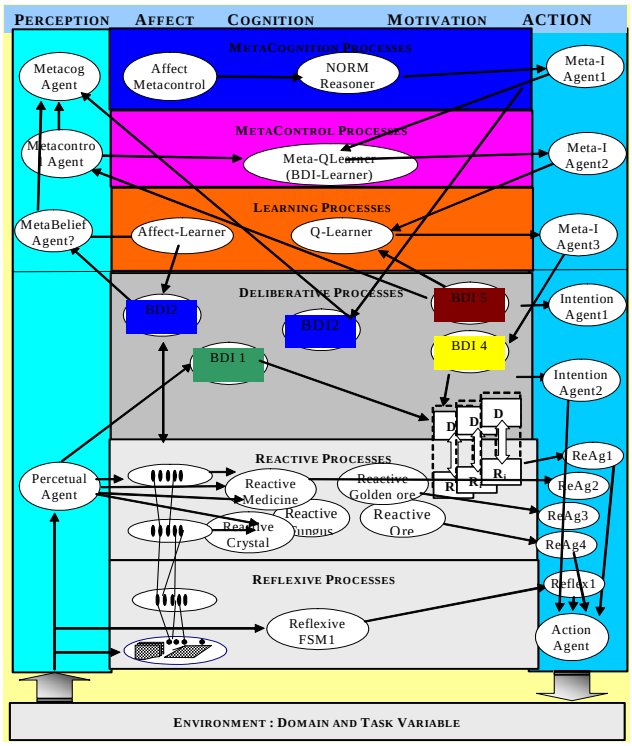


Fig4: SMCA

The SMCA (Society of Mind approach to Cognitive Architecture) utilizes a generic architecture, and developed in terms of generic and metacognitive agent types. The main aim here is to model cognitive abilities and functions in terms of amalgamations of agents or isonomes. Each agent are designed so that it can fit to one of the following categories: (1) reflexive agents, (2) reactive agents, (3) deliberative (BDI models) agents, (4) learning, (5) metacontrol and (6) metacognitive agents.

The layers is filled or populated by several agents with deportments which respond to quandaries in the layers beneath, suppose in the case of the lowest reflexive layer, to environment. The perspicacity comportment is an amalgamation of simple demeanors. The model SMCA includes reflexive which has six demeanours , reactive which has seven comportments, deliberative which has fifteen demeanours , perceptual has nineteen deportments, learning has fifteen comportments, metacontrol is of fifteen demeanours and metacognitive is of seventy seven demeanours agents. From an perspective of the distributed model of mind which can be fitted with reflexive, reactive, BDI (Credence or belief, Desire, and Intention) agents or deliberative, perceptual, learner (Q learning), metacontrol, and metacognitive agents. [10]

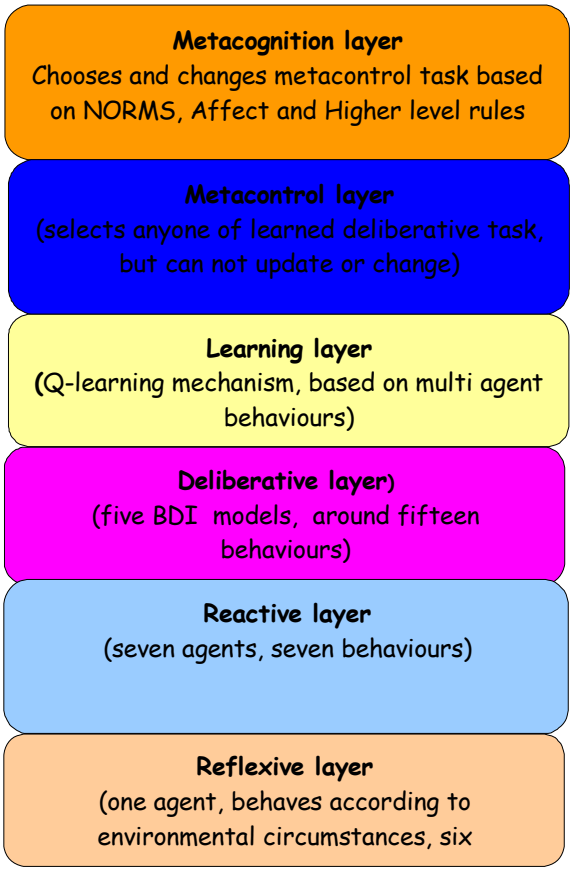


Fig5: Group of Distributed Agents in "Society of Mind".

### *D. Disadvantages of Existing Architecture:*

Existing architecture is no communication between the agents. Individual agents will perform the task hence the performance will be slow when compared to agents performing in a group. In EM-One architecture there is communication between only two agent.

### *III* PROPOSED ARCHITECTURE- SWARM AMBIENT COGNITIVE ARCHITECTURE (SACA)

In this architecture we are using the concepts of ambient - swarm intelligence and cognition to build a self-configurable computational model, where the agents perform the task in swarm (group) to achieve the goal. By using SMCA as the base architecture, we are proposing SACA architecture. It is implanted using simulation. To investigate the concepts of ambient and swarm intelligence in detail with respect to motivation, coordination and performance. It also checks how performance varies by proper motivation and coordination.

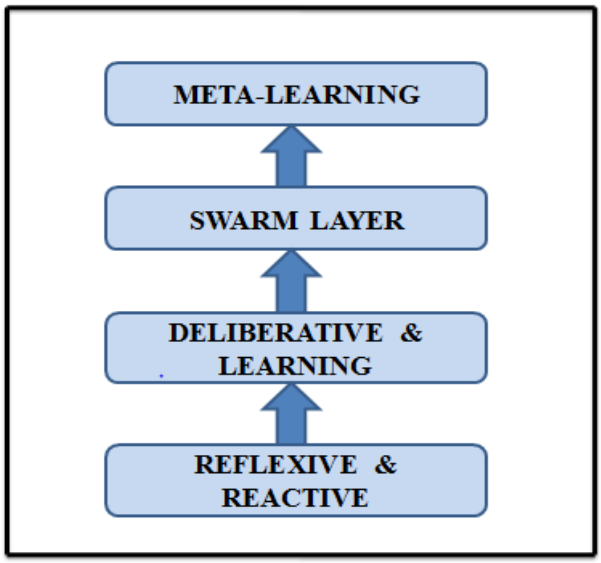


Fig6: layered architecture

1). Reflexive and Reactive layer:

Reflex action is derived from human and animal neuromuscular action. The reflexes are built-in mechanisms. Action can occur expeditiously, afore cerebrating. In some cases, reflexes can be transmuted or overridden; a reflexive agent cannot have any explicit motivational states like credence, desire, or intentions. For example, in a testbed, a reflexive agent can move in one of four directions that is left, up, down, right in replication to the nature of the environment immediately in front of it; it is simply moving into free space and moves away from obstacles. reactive agent mechanisms are having the flexible control mechanisms, they can be homogeneous described by Kaelbling (1986). The classes of agent have perceptual pathways and mechanisms for decision making, and deportments across intended actions. For example, in the testbed that is developed, reactive agents follow a exact goal. The goal is to identify the resource, move shortest way to achieve it and accumulate any one or more resources.

2). Deliberative and learning:

Deliberative agents build on the comportments which can be utilized in the reflexive and reactive agents. The deliberative actions are orchestrated and coordinated in terms of the agent, its state, motivations and its perception of resources in the environment. Mind can be composed of many minute processes; which are called as deliberative or phrenic agents. Each phrenic agent by can do some simple things. BDI (Belief, Desires Intentions) are the noetic components present in agent architectures (Bratman, 1987; Cohen 1990; Rao and Georgeff, 1993). In the developed testbed, deliberative agents reasons their own tasks and plans. agents of fungus world testbed are capable of performing different tasks. The deliberative agents can reverse the reactive and reflective agents, from the reasons predicated on the Credence, Desire and Intention set.

3). swarm Layer:

In the deliberative and learning layer the agents define their path and move in the form of the swarm. Anything in group is called as swarm. In this layer the agents they move towards the destination and then they move towards the treasure in the form of swarm. To exibit the various control mechanism and technique thus demonstrating “Swarm Intelligence”. Agents behaviour can be analysed by social interaction in group with respect to the environment. Here the interaction will be indirect.

4). Meta learning layer:

Metalearning agents can control and monitor their progress in performing cognitive tasks or metacognitive regulations (Wilson & Keil, 1999; Adkins, 2004). Reflective processes with capabilities of learning can lead to this mechanisms. These agents are necessary for the optimal decision-making in the environment. For example, in the testbed which is developed, metacognitive agents chooses any metacontrol task. They can select, change, update and reason for any metacontrol task.

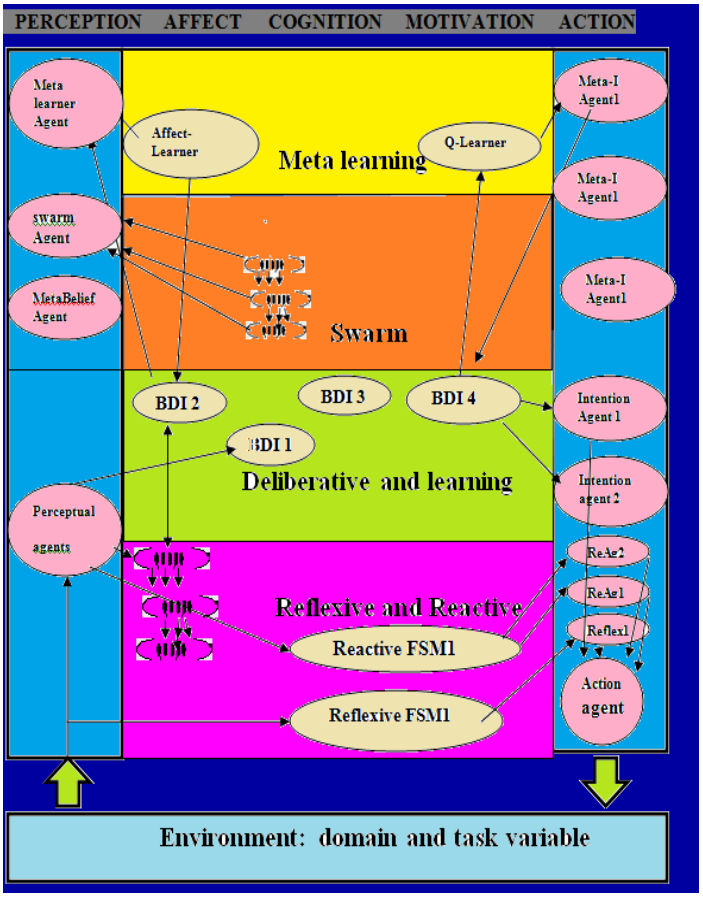


Fig7: Detailed layered architecture

The purport of this is to understand natural minds theory and adopt the principles into the simulation world of artificial minds. The theory includes abstract of architectures to fortify the functioning which is associated with mind. Design and implementation of a concrete architecture which follow the hypotheses of human and artificial minds. This approach obligatorily requires designing of the different computational simple and intricate level agents. They are verified by optically discerning how they will coordinate to their goals by orchestrated solutions and the general process of cognition to ameliorate performance (Franklin, 1995, 1996, 1997). An agent senses and acts in its environment. The researchers who are involved in agent research, they have offered a variety of formal and informal definitions of an agent. Russell defines an agent as "anything that can be viewed as perceiving its environment through sensors and acting through the environment through effectors" verbally expresses that "autonomous agents are systems capable of autonomous, purposeful action in the authentic world" [10]

*Advantages:*

It can be used in military applications.

A highly motivated agent communicates with each other and hence increases performance.

## CONCLUSION:

The proposed cognitive architecture is mainly concentrating on the communication between the agents in Swarm.

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