Hybrid Intelligent Systems

Lecture 17

Future of HIS and AGI.

Emotions, motivation, consciousness

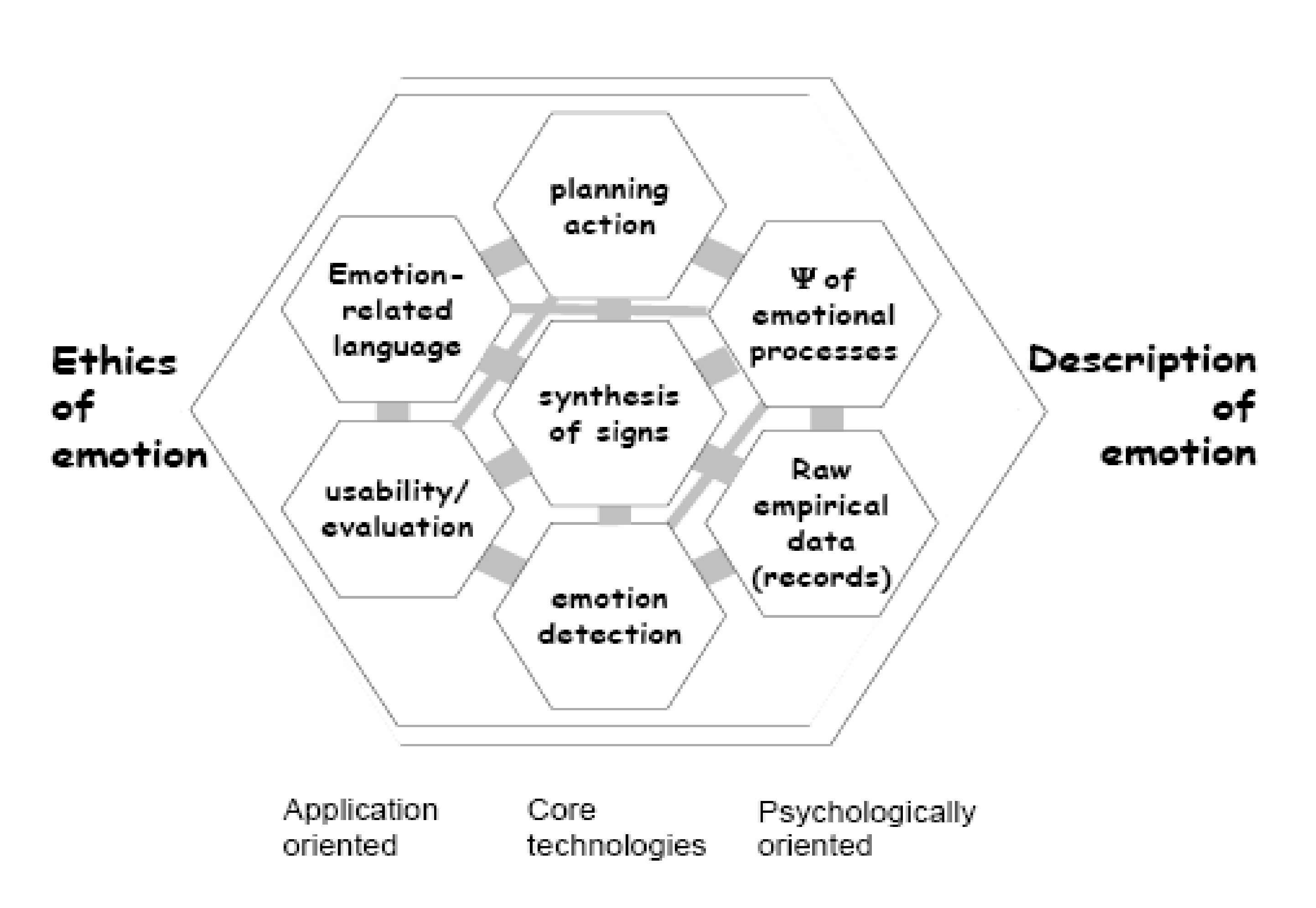
Can an intelligence create another intelligence more intelligent than itself?

- Conditions
  - Same or similar to mind principles of thinking and learning
  - More speed of action
  - More volume and accessible of memory
  - Available of evolution

What is AI similar to our mind

- Similarity of learning
- Similarity of perception
- Similarity of memory
- Similarity of thinking
  - Motivation
  - Emotions
  - Goals
  - Consciousness

Developing a consistent view on emotion-oriented computing. Marc Schroder and Roddy Cowie



Equipping a Lifelike Animated Agent with a Mind

L. Chen, K. Bechkoum, and G. Clapworthy

IVA 2001, LNAI 2190, pp. 72-85, 2001.

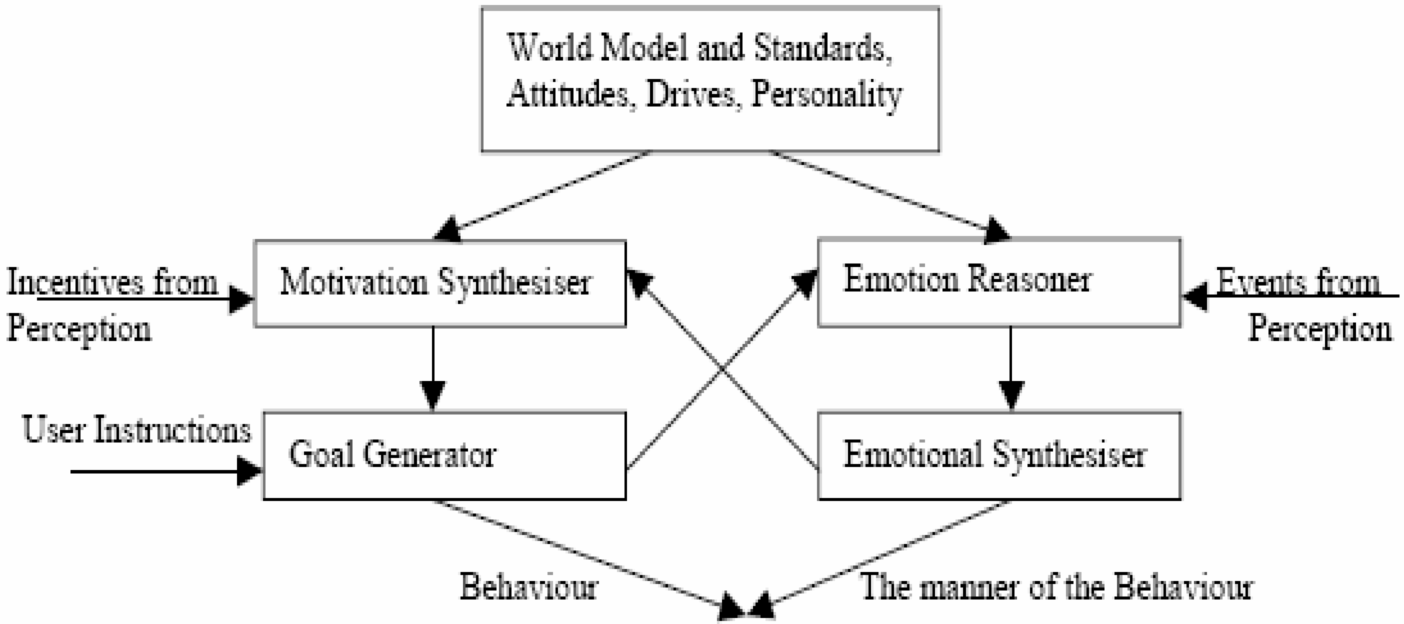


Fig. 1. Mind model

Components of motivation

Table 1. Static motivation hierarchy

Motivation Category	Interpretation for an agent	Weights
Physiological	Drinking	W_{phys}
Safety	Avoid collision & hostile agents	W_{safe}
Affiliation	Cooperation, social activity, Helping others	W_{aff}
Achievement	Achieve its own goals	W_{ach}
Self-Actualisation	Learning & creative activity	W_{learn}

Model of motivation

$$\mathrm{SoM}_{it} = W_{catei}\left(\sum_{k} D_{kt} W_{k} + \sum_{j} I_{jt} W_{j}\right).$$

name <motiName>
static prio < one of the five category weights>
participants <names of participants>
incentives <set of (first-order) formula or variables>
drives <set of drive formula or variables>
drive change <temporal function >
motivation strength < a calculation function based on Equation (2)>

Fig. 2. Abstract description of a motivation

Algorithm of motivation arbitration

- 1) Set the motivational profile of the agent.
- 2) Specify the initial situation such as internal drives, incentives, goals and objects. Then at each time step:
- 3) Compute the strength of all motivations and rank them according to their magnitudes.
- 4) Choose the first motivation Fm.
- 5) Compare the Fm with the current active motivation. Make the motivation with bigger magnitude active.
- 6) Map the active motivation to its corresponding goal g. (in Goal Generation module)
- 7a) Pursue the active goal (in the Behavior Engine)
- 7b) Continue the loop from the step 3 while the agent proceeds to step 6 and 7a.

Abstract description of goal

- goal_name < goalName>
- goal_descr < a set of formula >
- participants <name of involved objects or agents>
- importance < integer >
- preconditions <a set of formula>
- commitment status < one of active, successful, rejected and failure>
- plan < controller>

Emotion representation

- emotion_name < emName>
- type <one of the 24 types>
- intensity < integer >
- causes < set of formula>
- directional <the bearer of the emotion effect>

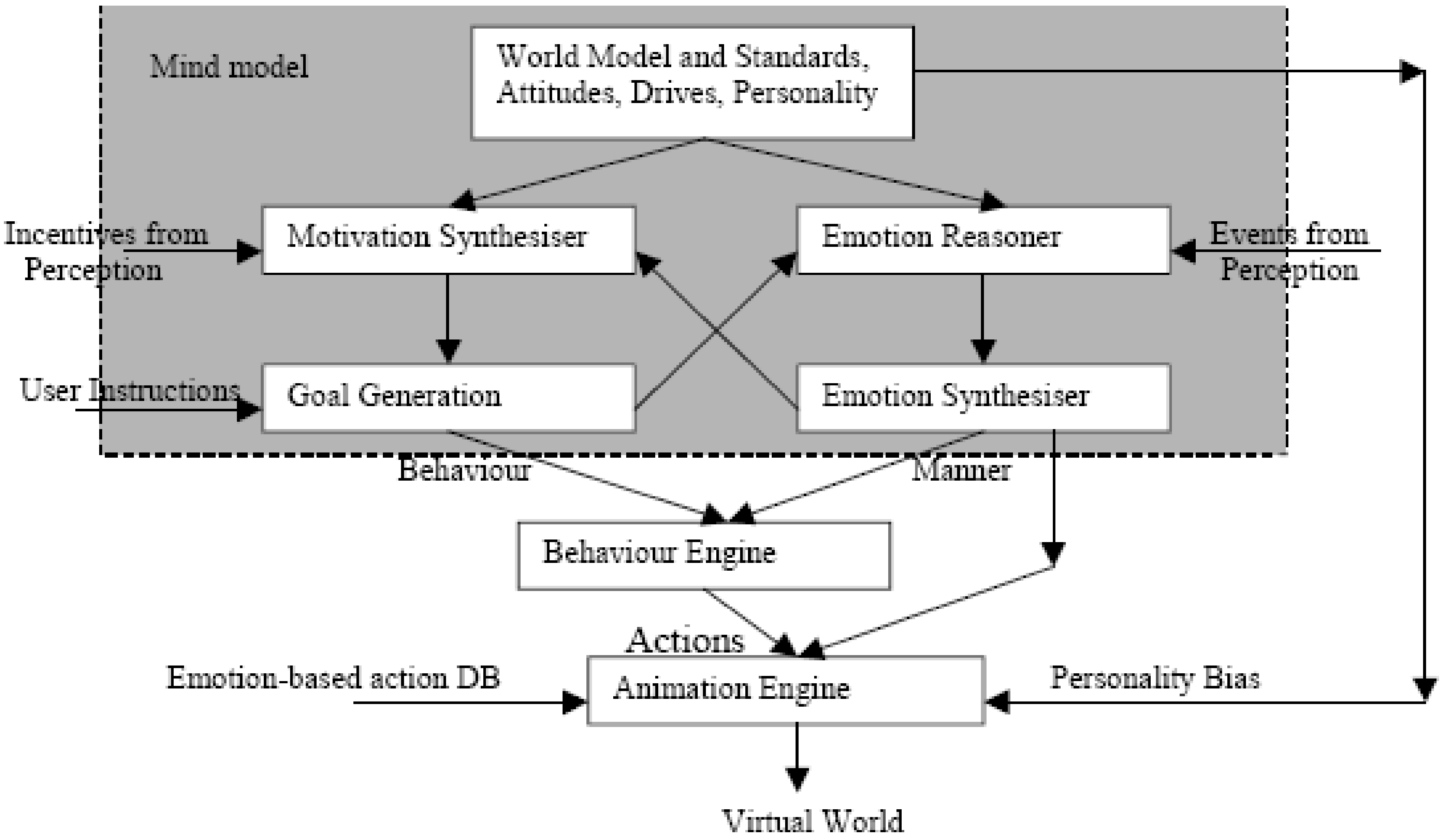


Fig. 5. Agent architecture

Algorithm of motivation arbitration with emotions

- 1) Set the motivational profile of an agent.
- 2) Specify the initial situation such as internal drives, goals and objects.
- At each time step:
- 3) Implement cognitive appraisal and generate the current emotional state.
- 4) Compute the strength of all motivations taking into account emotion influence and rank them according to their magnitudes.
- 5) Choose the first motivation Fm.
- 6) Compare the Fm with the current active motivation. Make the motivation with bigger magnitude active.
- 7) Map the active motivation to its corresponding goal g. (in Goal Generation module)
- 8a) Pursue the active goal (in the Behavior Engine)
- 8b) Continue the loop from the step 3 while the agent proceeds to step 7 and 8a.

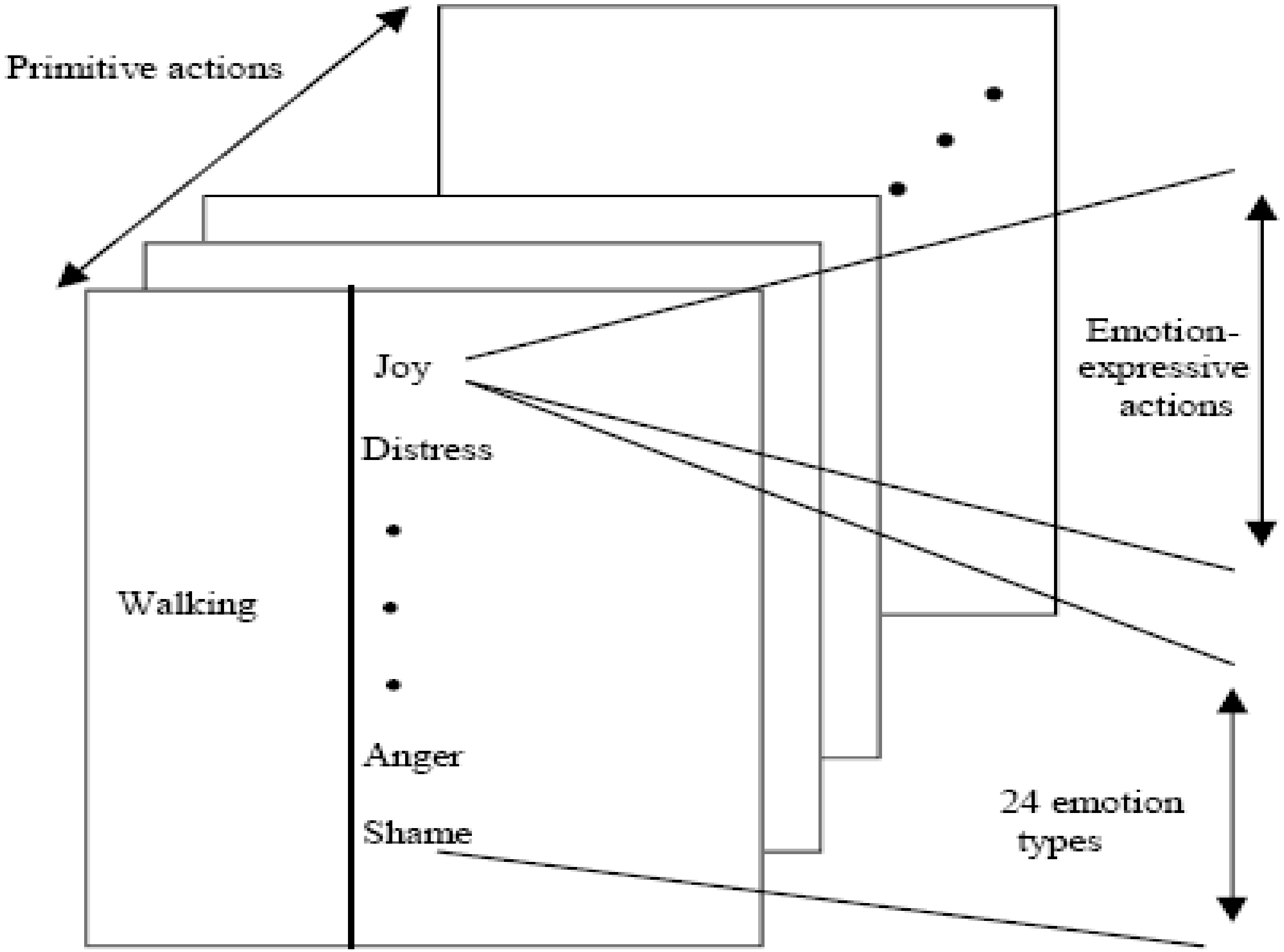


Fig. 6. Structure of emotion-expressive actions

The interface agent in virtual environment

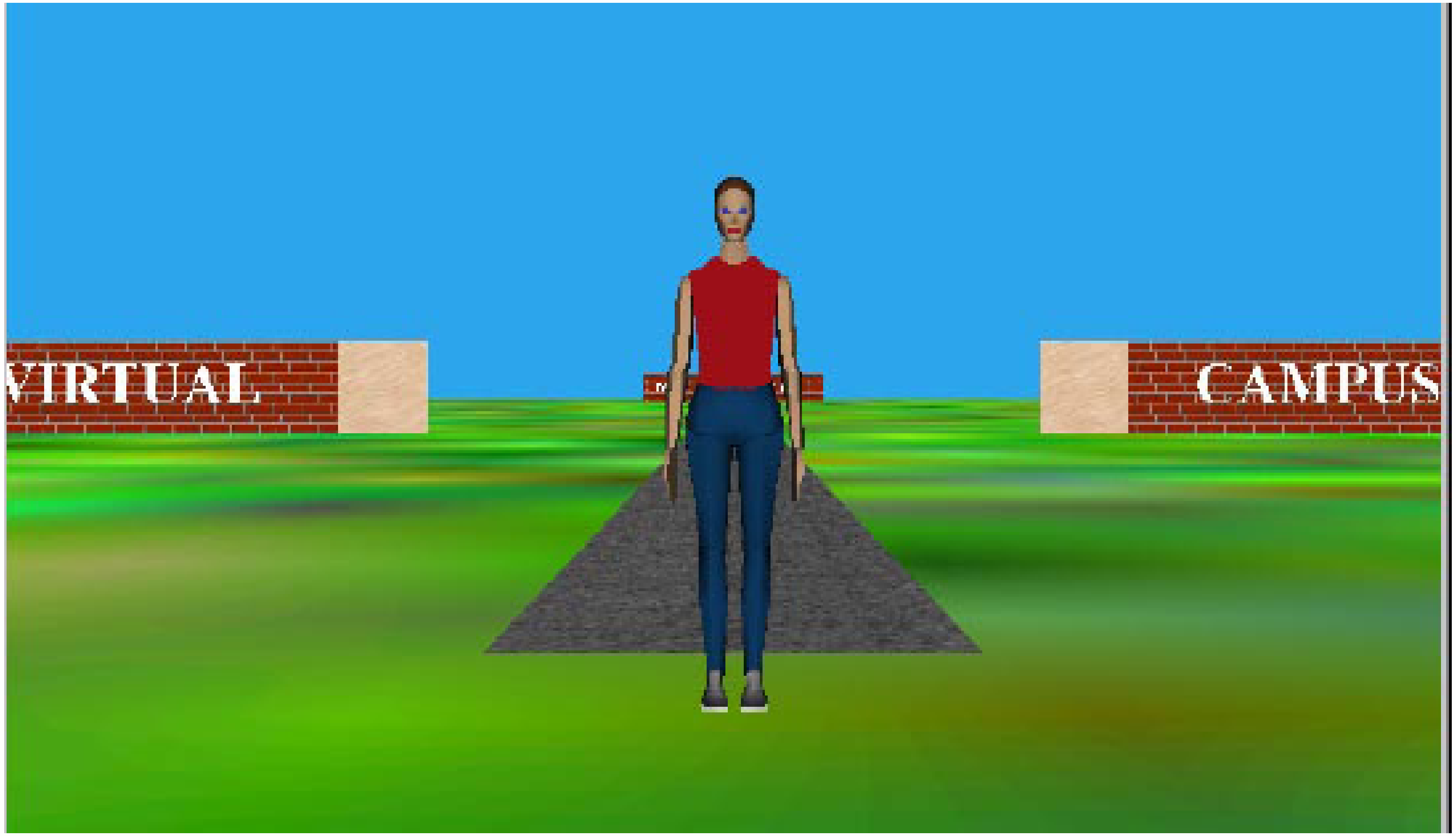


Table 2. Motivation modelling of interface agents

Motivation category	Motivations	Drives	Stimuli	Goals
Physiological	Drinking	Thirst	Water	Godrinking
Safety	Collision avoidance	Security	Obstacles	CollisionAvoidance
Affiliation	Greeting	Sociability	Agents	Greeting
	Provide information	cooperation	Upon request	ForwardInfo
Achievement	Achieving its own tasks	Accomplish tasks	Task-oriented	Goto(pos) or Do(thing)
Self-Actualisation	Self-amusing	Boring	None	Selfamusing
	Navigation & exploration	Curiosity	Unknown area	Navigation
	Learning,			
	creative activity			

Motivated Agents.
Kathryn Kasmarik, William Uther, Mary-Lou Maher,
IJCAI-2005

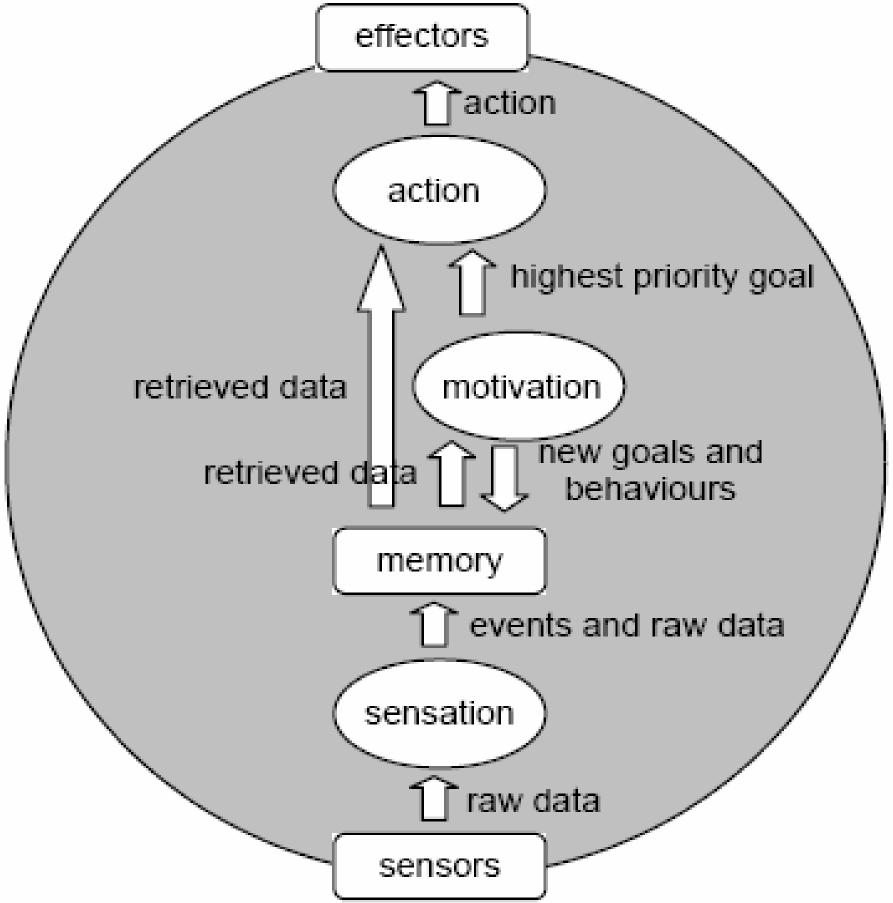
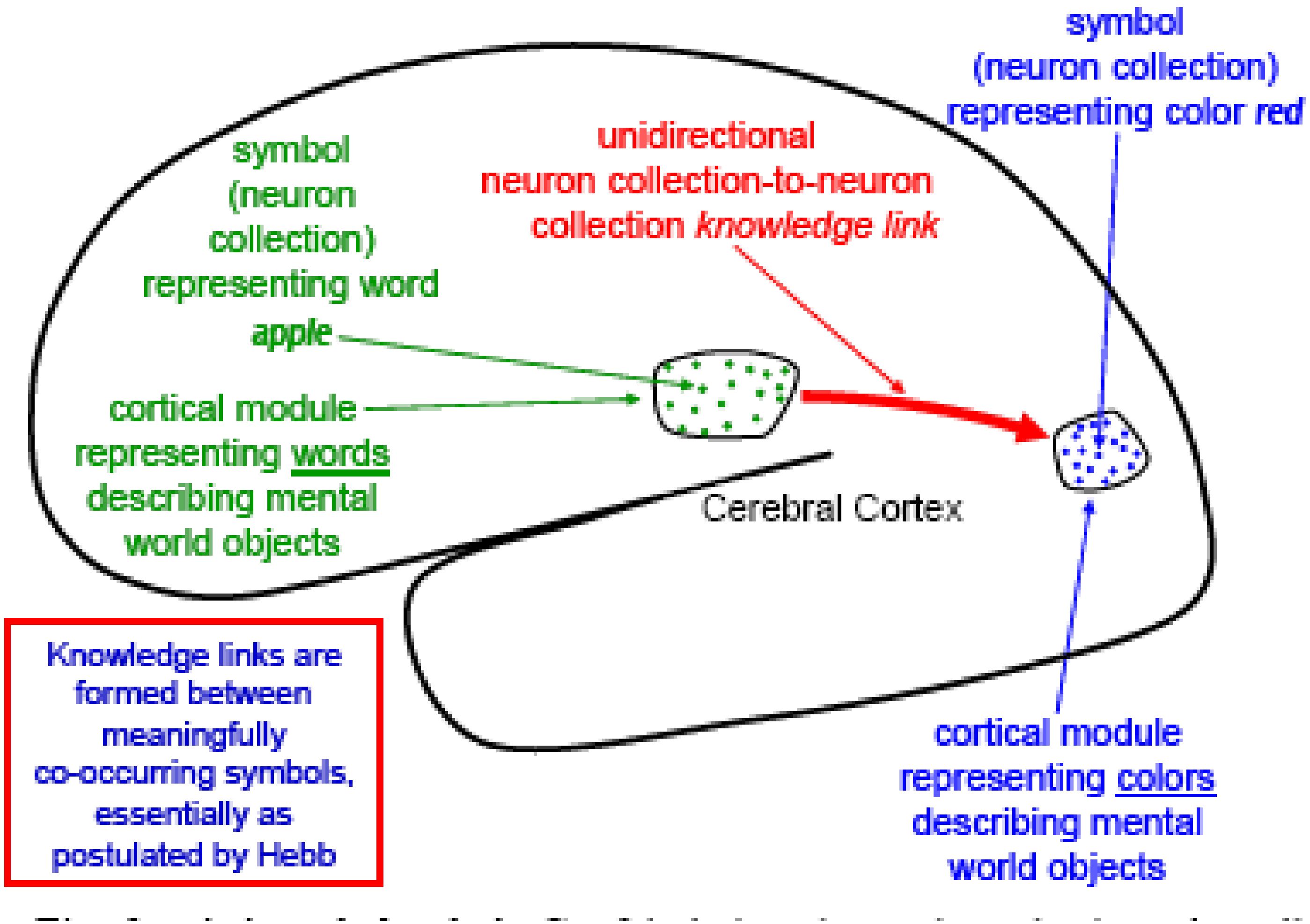


Figure 1 – The motivated agent model.

The Mechanism of Thought,

Robert Hecht-Nielsen

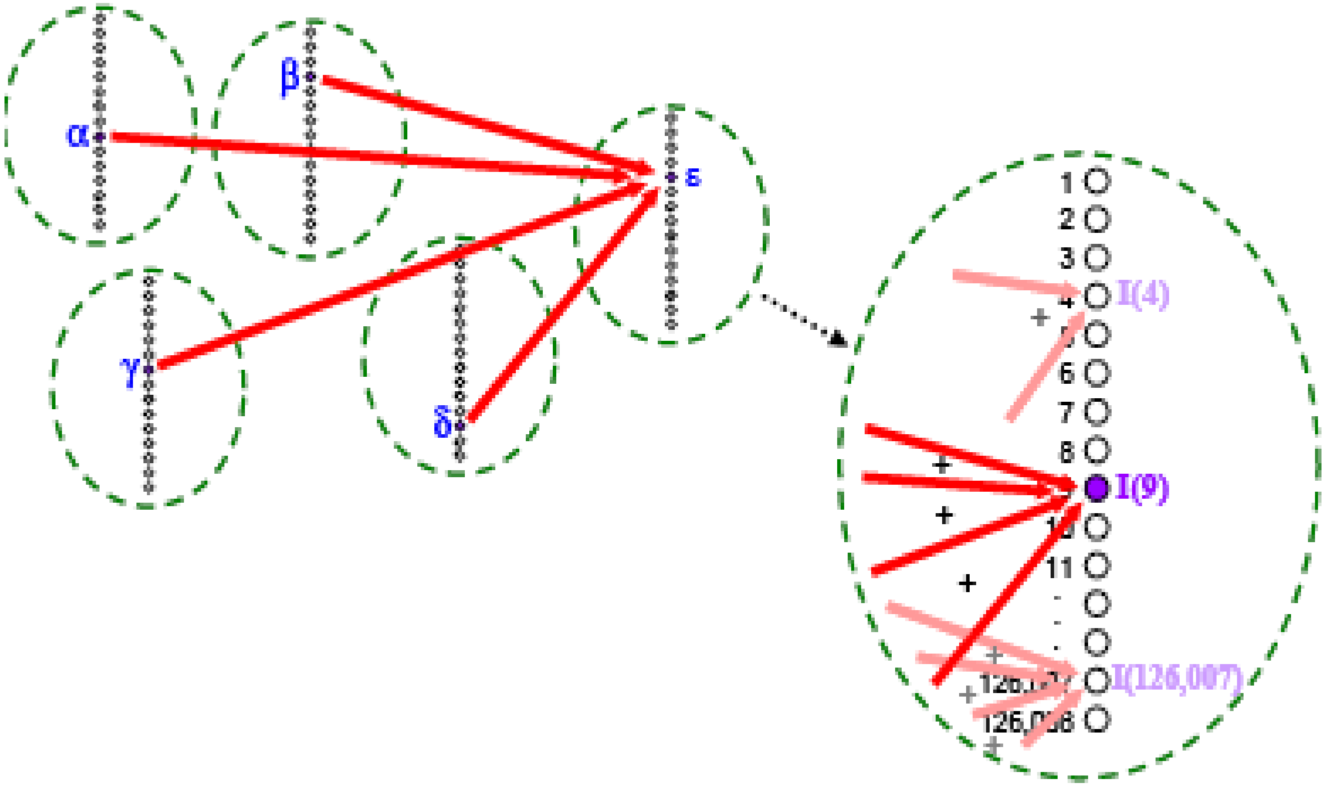
IJCNN-2006, Vancouver, BC, Canada, pp. 1146-1153



Theory of confabulation

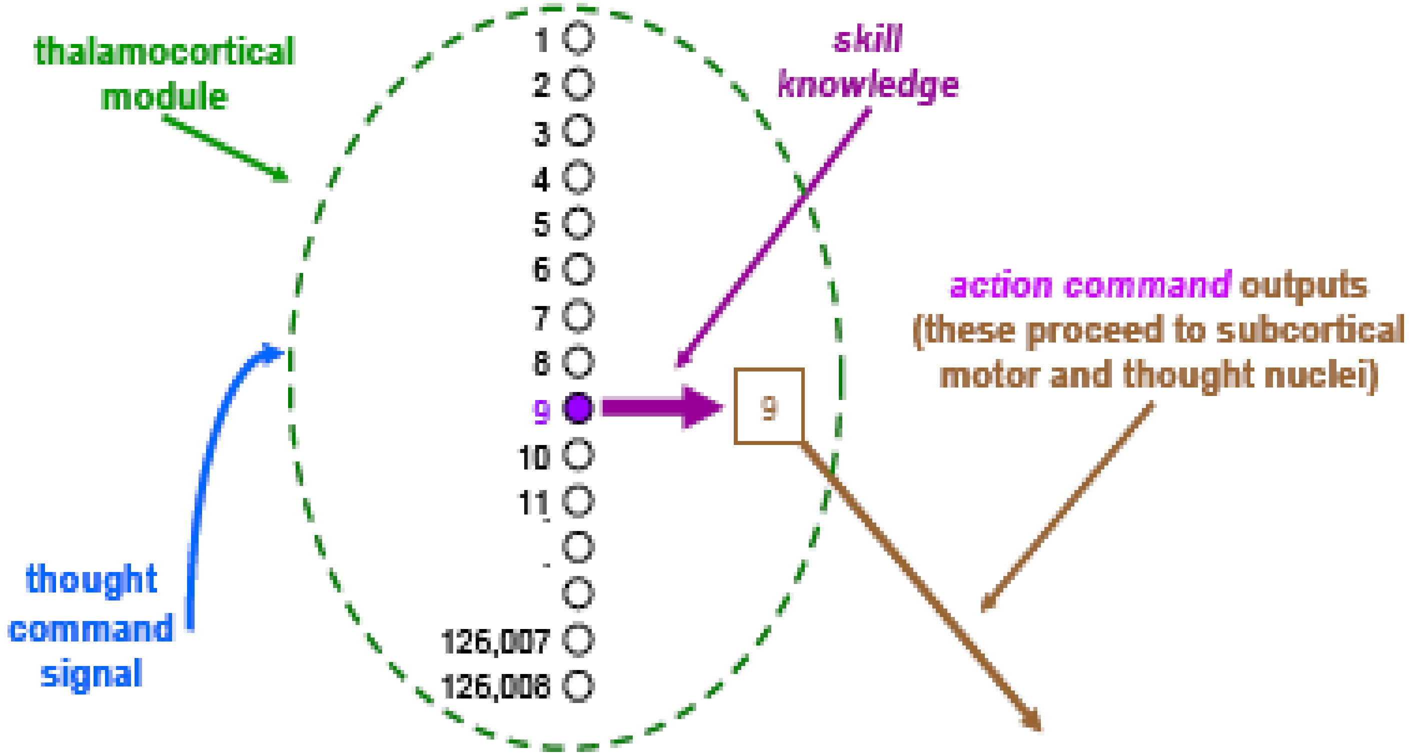
- COGNITIVE WORLD OBJECT REPRESENTATION
  - Each module is used to represent one *attribute* that an *object* (visual, auditory, conceptual, abstract, motor process, thought process, plan, etc.) of the cognitive mental universe may possess. This representation takes the form of the selection of a single *symbol* from among a set of (typically) thousands of symbols implemented by the module for describing its object attribute
- KNOWLEDGE LINKS
  - Each *knowledge link* connects the neuron collection representing one symbol (termed the *source symbol* of the link) to neurons representing a second symbol (termed the *target symbol* of the link – usually a symbol in a different lexicon from that of the source symbol)
- CONFABULATION
  - each module is also responsible for carrying out the *confabulation* operation (a ‘winners-take-all’ competition process among the symbols of the module)
- THE ORIGIN OF BEHAVIOR
  - every time a confabulation operation being carried out by any module yields a *definitive conclusion* (namely, one symbol – not multiple symbols or no symbol), a set of *action* (movement process and/or thought process) *commands* associated from that particular conclusion symbol are immediately launched

Confabulation



Confabulation – the lexicon-level view. Confabulation is a winners-take-all competition between the symbols of a module, based upon each symbol's total knowledge link *input excitation*

The *conclusion-action principle*



Confabulation theory

- Fundamental underlying mathematical operation of cognition is to find that symbol ε of the answer module which maximizes *cogency* p(αβγδ|ε).
- Cogency is the probability of the assumed facts being true, given an assumption that the symbol ε is true.
- In other words, confabulation theory claims that each decision making process involved in cognition is selection of that conclusion which is most supportive of the employed assumed facts being actually true

Principles of action of intelligent systems

A.V. Gavrilov, IST-2003, Novosibirsk and in http://www.mind-consciousness-language.com (2007)

- **The principle of associative recall**
  - *When interacting with the environment, the intelligent system stores the associations between different images (stimuli, signals, signs, actions, etc.) which it uses to plan and execute its behavior. The associations originate from a recall process (reading associations from memory) of images based on their fragments. The associations that are involved during the storing process are reinforced. When sufficiently consolidated, the associations can be used to denote the relations (attributive, cause and effect, case, etc.) between entities*
- **The principle of concentration and economy of resources**
  - *Intelligent systems (natural or artificial) have a mechanism that selects (recognition) and activates the information resources (neurons, neural ensembles, frames, rules, etc.) that are essential to the solution of an actual task by the intelligent system, and that deactivates the resources that are not essential to the solution of an actual task*
- **The principle of uncertainty**
  - *The more precise the recognition of the structure of an image, i.e. its internal semantics, the less accurate the recognition of its interaction with other images, i.e. its external semantics*
- **The principle of unity in fuzzy reasoning and certain other operations**
  - *The basis of reasoning lies in operating with fuzzy images by means of a process of associative recall of images (see Principle No. 1). At the end of the process, a choice of certain operations is carried out (recalling of it): it is therefore possible to associate the successful choice (the solved task) with the focusing of attention, the start of operation as programs of operation motor neurons, etc. Thus the selected operation is involved as a tag in the further process of reasoning*