Volume 2, No. 4, July-August 2011
ISSN No. 0976-5697
International Journal of Advanced Research in Computer Science
TECHNICAL NOTES
Available Online at www.ijarcs.info

# Systems Management of Alert Responsive Tasks: SMART A.I.

Ian James Malloy
S.T.A.I.R. Lab (Software Theory and Implementation Research)
Malloy Labs, LLC
Sioux Falls, United States of America
malloy.labs@gmail.com

***Abstract:*** The engineering of SMART was funded by the NASA South Dakota Space Grant Consortium and resulted in the architecture outlined in this technical write-up. The entire system has been proven decidable by modeling the system in a predicate calculus that was converted into a context-free grammar. A compiler has also been included in the system to convert the regular languages into an irregular language. SMART (patent pending) is multi-sensory intelligence capable of unifying all input into a single representation to calculate tasks to be performed. It is currently being implemented in SWI-Prolog. This research has been presented at Augustana College's (Sioux Falls, USA) annual Symposium in 2011 and can be viewed at www.youtube.com/malloylabs.

***Keywords:*** cognition, binding, artificial intelligence, multi-sensory intelligence.

## I. INTRODUCTION

The sub-processors handle simple processing such as edge detection, parsing, and sentence compiling. The PDA: SMART, given that it is designed for the Systems Management of Alert Responsive Tasks is the arbiter of all action including speech production, walking, grasping, and avoiding. The system is only designed to listen to human voices at this point and ignore all other sound input, but will be programmed with certain voice commands to control the completed machine.

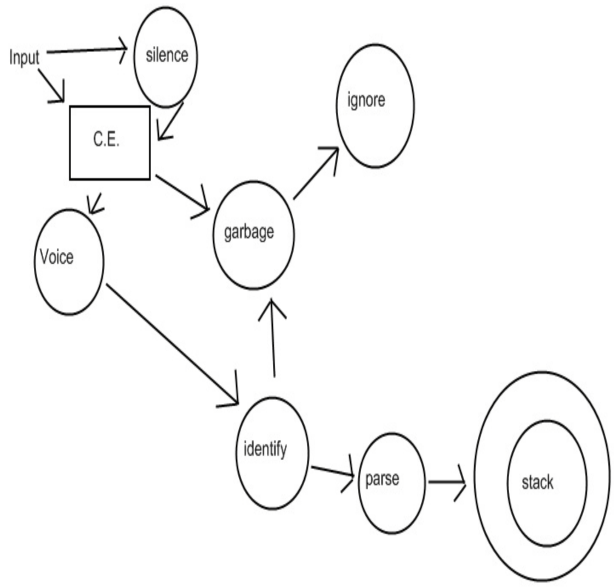
SMART will store names of people and objects, information, and commands in a memory base. The type of input allowed by the sub-processors must be limited to prevent SMART processing in exponential time. A small memory unit must be attached to the PDA:c.e. that stores discrete states of information taken from input and sends it to SMART through the Unitary Representation of Input, or URI. The stacks for SMART will contain representations of identified input signals for SMART to decide upon.

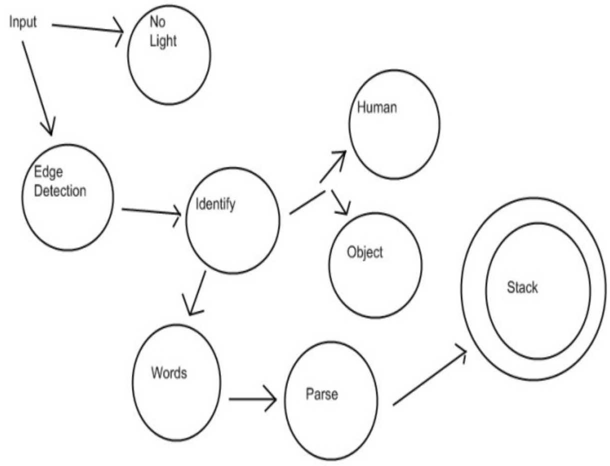
SMART will control movement and speaking and while the PDA:c.e. helps govern all sub-processors as they parse incoming information relative to the type of input the sub-processor are meant to process.

The sub-processors (sp's) must process in parallel but input to PDA:c.e. serially and continuously, it will more than likely occur that each sp intrinsically has a different processing time built into the program it is running. This will avoid having to create a decision algorithm that would limit the representation of the environment that SMART will have. Following are the computational models of the AIS. These refined models detail exactly how the system will operate.

## II. METHOD

State Diagrams of the Sub-Processors:



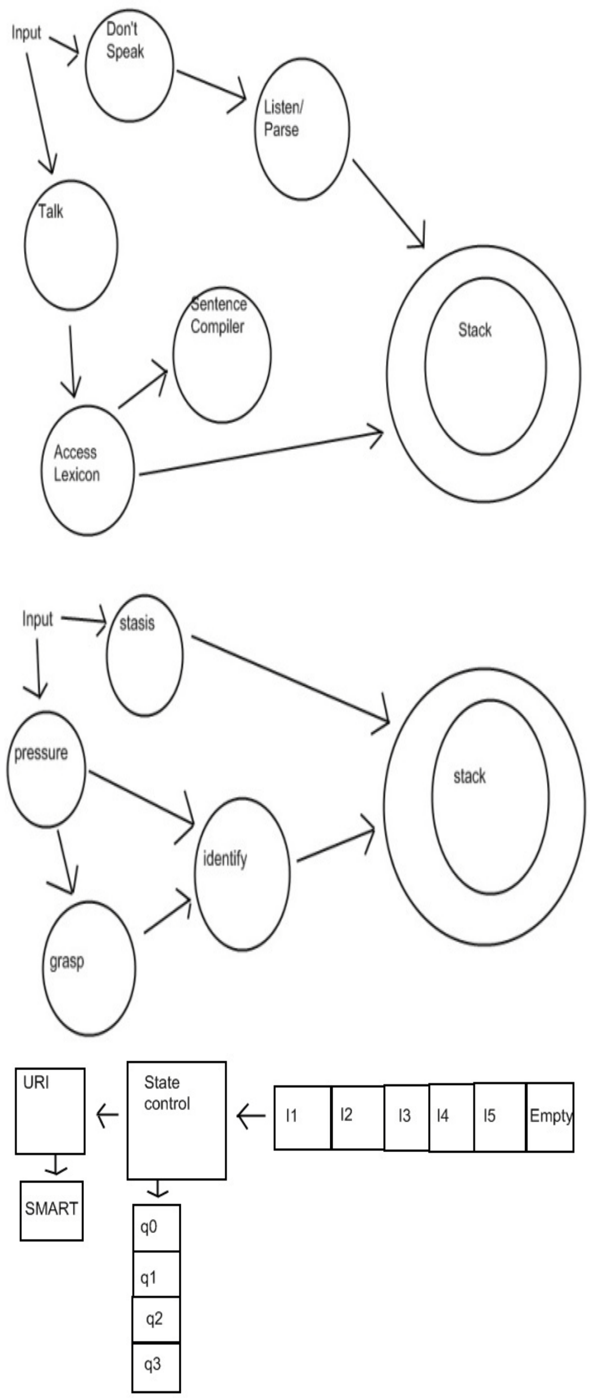



Figure 1

## III. RESULTS AND DISCUSSION

Axioms:

1. $n \ni x$
2. $\limsup_{n\to\infty} n = S^*$
3. $S^* = +\infty$
4. $[P \to (P = P)]$
5. $[P \to (P\ v\ P)]$
6. $[P \to (P\ v\ {\sim}P)]$

Definitions:

1. $\left(\left(\left((\Omega \to P) \to (x_n \ni P)\right) \to (P \cap x_n)\right) \to (P \equiv x_n)\right)$
2. $\lim_{\frac{A}{B}\to P} \left(\frac{A}{B}\right) = x$
3. $\lim_{S_0 \to \frac{A}{B}} S = x^{-1}$
4. $\lim_{\frac{A}{B}\to S} \left(\frac{A}{B}\right) = -x$
5. $\lim_{AB \to \sum_1^t n} (AB) = x^2$
6. $\lim_{t\to AB} t = ([s \cap x] \to [t \cong (.3, .5) seconds])$
7. $[\lim_{n\to\infty} \int_{q_0}^{b} (f_n - f) dP = 0]$
8. $[\lim_{n\to\infty} \int_{q_0}^{b} (f_n - f) d\Omega = 0]$
9. $\{\lim_{n\to\infty} [\overbrace{f_n(\Omega)}^{(P)} \,\&\, \overbrace{f_n(P)}^{(\Omega)}] = \left[(f_i(P) \ni P) + (f_j(\Omega) \ni \Omega)\right]\}\ for\ (P, \Omega)$

$\left(\frac{1}{x}\right) + x^2$ Where x denotes a representation and the equation represents the binding problem shown graphically:

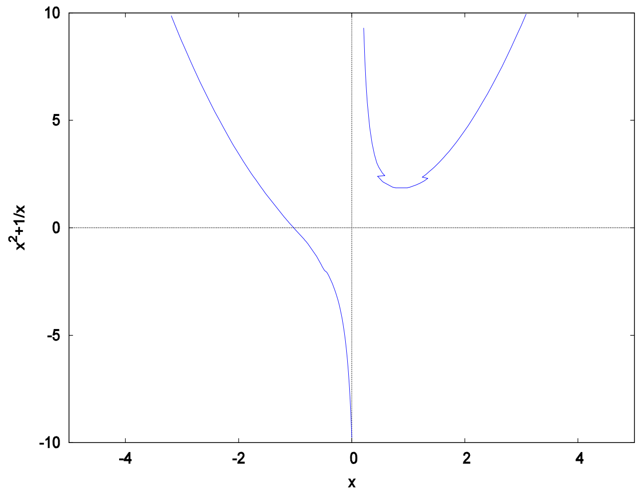



Figure 2

1. $\Omega$ represents any core processor

The axioms of the processing and implementation of SMART are as follows, the variables used are meta-variables which can stand for any process, input, or state:

The independence theorem of stacks: $\{(\alpha \& \beta) \to ({\sim}\alpha \to \beta)\}$ where alpha is input from one stack and beta is input from the other stack.

Accessing of a state through a transition state:

$\{(\psi \to \Omega) \to (\Omega \to \alpha)\}$ where psi is any state and omega is a discriminatory state then alpha is a defining state, or psi may be any start state and omega may be a transition function to an end state, which relative to the NFA's would be isomorphic to input it's end state to the PDA:c.e. storing it's definitions and discriminations.

Discriminating Theorem: $\{(\alpha \& \beta) \to (\alpha\ v\ \beta)\}$ where alpha is currently in conjunction with beta and then the two are seen as a bifurcation wherein the non-dual input may be seen as separate and two.

Axiom: $[P \to (P = P)]$ QED. Identity axiom of the AIS

Axiom: $[P \to (P\ v\ P)]$ Allows for a different state of P, receiving new updates from URI.

Table I

| variable | Calculations |
|---|---|
| F1 | (.29:.5)40 Hz |
| F2 | 40Hz/(.5:.29) |
| S | (.29:.2)40 Hz. |
| Fp | (.3:.5)40 Hz |
| T | 40 Hz/(.2:.29) |
| Temporal Factors | Cognitive Function |

| | |
|---|---|
| .2 seconds to .29 seconds | Stimulus entering Awareness |
| .3 seconds | Stimulus entering Consciousness |
| .5 seconds | Upper limit of Consciousness of a Stimulus |

Axiom: $[P \rightarrow (P \; v \sim P)]$ Open Mind Axiom. SMART incorporates cognitive binding based upon these calculations and saddle-node equilibrium:

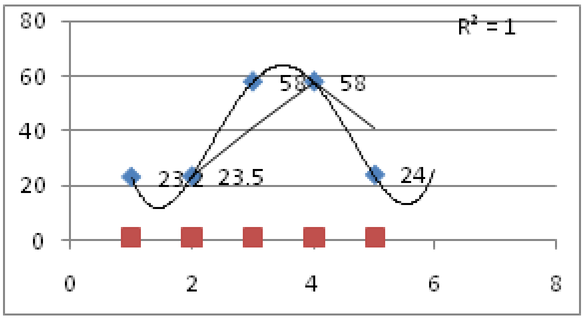



Figure 3

This figure illustrates cognitive binding and supports Engel and Singer (Engel and Singer, Temporal binding and the neural correlates of sensory awareness 2001) and Engel (Engel, Time and conscious visual processing 2003) and is structured around the studies of Doesburg, et al. (Doesburg, et al. 2007). The graph is move forward one period and the moving average is calculated over two periods and results in approximately forty Hz. Moving the periods of the moving average forward several periods results in a resting phase at approximately forty Hz., making this saddle equilibrium multi-stable given the multiple attractors (Izhikevich 2007). Removing the positive attractor and ensuring that the two negative attractors do not converge results in the graph of the function of the binding problem detailed in this article. The algorithms suggested as the computation of binding presented as definitions of SMART should result in a unified representation input to SMART for calculated interaction.

The five-tuple of State Diagram 1 is as follows:

$$Q = (q_0 \ldots q_6)$$
$$\Sigma = (1,0)$$
$$\delta\colon \left(\sum \varepsilon \, x \, Q\right) \rightarrow P(Q)$$
$$q_0 \in Q$$
$$F \cap Q$$

$F = \{q_3, q_5, q_6\}$ Where F is an accept state. Given input that is empty, epsilon moves to the start state, which is analyzing silence. If the input is one, the sound is sent to the PDE:c.e. for the requisite sub-processor where the c.e. focuses the parser to discriminate the input into either a human voice, determined relative to the frequency of the sound, or 'garbage' input. This either outputs a 0 or 1, where 1 or silence between words is sent to an identifying state where silence is denoted by epsilon. Then the continued or silenced statement is sent to a parser, which identifies words based on phonemes and a coded representation for the feature of letters. The proto-letters must have identifying features that create a range of values which can be used to distinguish probability of letters given previous and following letters as well as grouped phonemes in a sentence. The only added process to the first State Diagram is that it makes the discrimination of human voice or unimportant sounds. To avoid overworking the processors, a learning algorithm to allow the machine to learn other sounds isn't advised.

The accept states for the first sub-processor are:

1) ε11111
2) 11111
3) 11ε11
4) 11εε1
5) 11εεε
6) 111εε
7) 1111ε
8) ε11ε11
9) ε11εε1
10) ε11εεε
11) ε111εε
12) ε111ε1

These accept states determine the type of input to the stack of its relative PDA:c.e.

The five-tuple of the second State Diagram is as follows:

$$Q = \{q_0 \ldots q_7\}$$
$$\Sigma = \{1,0\}$$
$$\delta = \Sigma_\varepsilon \, x \, Q \rightarrow P(Q)$$
$$q_0 \ni Q$$
$$F \cap Q = \{q_4, q_5, q_{6,} \; q_7\}$$

The input strings that lead to accept states are as follows:

11111
10111
11011
10011
11000
10000

The discrimination algorithm is used both for the processor to decide and to process the information it is meant to take in, instantiating variables specific to this processor would be color fields and edges as well as input from an infrared sensor that detects distances of objects. The infrared beam would be shot through the center of each 'pupil' and angled so as to permit the point to lie exactly on the center of the visual field of the machine. It might be in the interest of the machine to use a cube grid containing the visual field so that distances can be calculated based upon the information conveyed by the infrared sensor. This would also aid in discrimination because it would be a reference point for identifying curves, lines, fields, and text.

The five-tuple of Visual Object Discriminator is as follows:

$$Q = \{q_1, q_2, q_3, q_4, q_5, q_6\}$$
$$\Sigma = \{0,1\}$$
$$\delta\colon \Sigma_\epsilon \, x \, Q \rightarrow P(Q)$$
$$q_0 \in Q$$
$$F \cap Q = \{q_6\}$$

The input strings that lead to accept states are:

1. εεε
2. 100
3. 1110
4. 110

The five-tuple for the Movement Processor is as follows:

$$Q = (q_0, q_1, q_3, q_4)$$
$$\Sigma = (0,1)$$
$$\delta\colon \Sigma_\epsilon \, x \, Q \rightarrow P(Q)$$
$$q_0 \in Q$$
$$F \cap Q = \{q_4\}$$

The delta transition function is an application of the discrimination model and is the same for all five-tuples.

The system as a whole is a combination of several units, where a single unit is a set of sub-processors giving output to a single central executive with access to the unifying representation of input processor model on cognitive binding and working memory. This unified representation of input feeds output to S.M.A.R.T. which then ultimately decides the response or goal of the machine.

A complete systems model of S.M.A.R.T.:

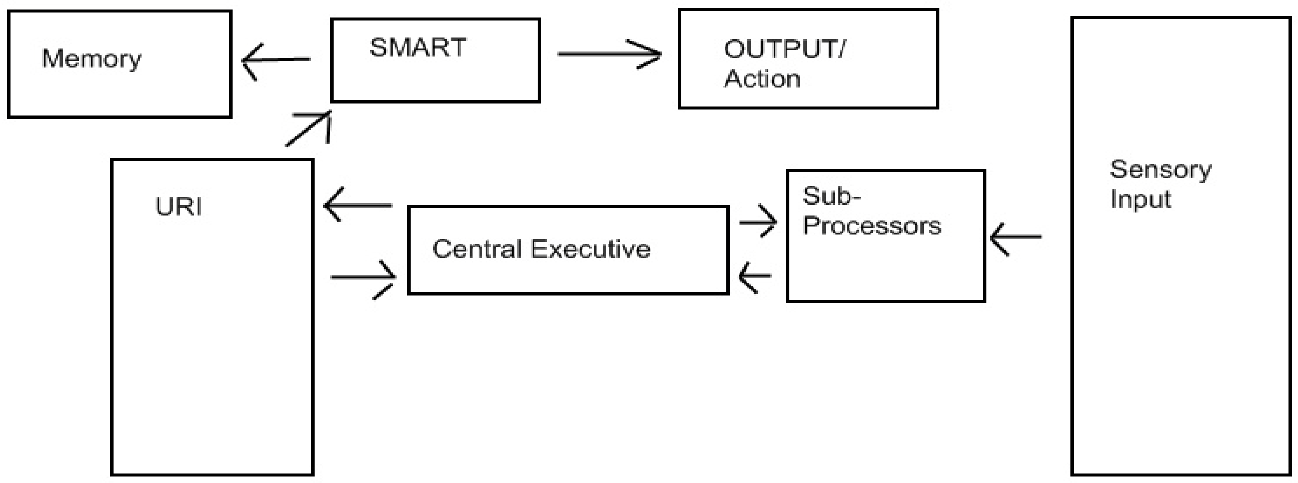



Figure 4

As stated, one unit consists of four sub-processors sending signals to a C.E. which inputs URI's to its core, which is then translated into SMART's output. The generality of the system of algorithms for discrimination allow for very specific processes to be carried out by the sub-processors that allow for faster processing of SMART, since all input to SMART is essentially a vision of humans and objects with identification and definition, semantic in nature. With the added component of having two stacks to work with, processing time of SMART is increased further, and since it has access to its own memory store more detailed and defined data can be stored and indexed for future processing.

## IV. CONCLUSION

Minds have run rampant at the thought of a machine that thinks like a human. The models that compose the SMART system proposed in this paper represent a proto-brain devised by Bernaard J. Baars in his co-authored *Cognition, Brain, and Consciousness: Introduction to Cognitive Neuroscience* (Baars 2007). The desire was to use computational theory to map the relationship of input to functions and create a general set of algorithms that could be used in stimuli discrimination and representation.

## V. ACKNOWLEDGEMENTS

The Author would like to the NASA Space Grant Consortium for awarding the author funds to conduct this research, and the author would also like to thank Dr. Daniel Swets, Chair of the Mathematics and Computer Science Department at Augustana College (Sioux Falls, USA) for his continued guidance, critique, and support. The author would also like to thank Augustana College for providing the author the opportunity to present this research at Augustana's Annual Symposium in 2011.

## VI. REFFERENCE

[1] Baars, Bernaard J. "A framework." In Cognition, Brain, and Consciousness: Introduction to Cognitive Neuroscience, by Bernaard J. Baars and Nicholas M. Gage, 37. Academic Press, 2007.

[2] Doesburg, Sam M., Alexa B. Roggeveen, Keiichi Kitajo, and Lawrence M. Ward. "Large-Scale Gamma-Band Phase Synchronization and Selective Attention." Cerebral Cortex, 2007: 386-396.

[3] Engel, Andreas K. "Time and conscious visual processing." In Time and Mind II: Information Processing Perspectives, by Hede Helfrich, 141-EOA. Hogrefe & Huber, 2003.

[4] Engel, Andreas K., and Wolf Singer. "Temporal binding and the neural correlates of sensory awareness." TRENDS in Cognitive Science, 2001: 16-25.

[5] Herrman, Christoph S., H.J. Munk Matthias, and Andreas K. Engel. "Cognitive functions of gamma-band activity: memory match and utilization." TRENDS in Cognitive Sciences, 2004: 347-EOA.

[6] Izhikevich, Eugene M. Dynamical Systems in Neuroscience: The Geometry of Excitability and Bursting. MIT Press, 2007.

[7] Tidman, Paul, and Howard Kahane. Logic and Philosophy: A Modern Introduction 9th ed. Belmont: Thomson, Wadsworth, 2003.

### Works Cited

Baars, Bernaard J. "A framework." In *Cognition, Brain, and Consciousness: Introduction to Cognitive Neuroscience*, by Bernaard J. Baars and Nicholas M. Gage, 37. Academic Press, 2007.

Doesburg, Sam M., Alexa B. Roggeveen, Keiichi Kitajo, and Lawrence M. Ward. "Large-Scale Gamma-Band Phase Synchronization and Selective Attention." *Cerebral Cortex*, 2007: 386-396.

Engel, Andreas K. "Time and conscious visual processing." In *Time and Mind II: Information Processing Perspectives*, by Hede Helfrich, 141-EOA. Hogrefe & Huber, 2003.

Engel, Andreas K., and Wolf Singer. "Temporal binding and the neural correlates of sensory awareness." *TRENDS in Cognitive Science*, 2001: 16-25.

Herrman, Christoph S., H.J. Munk Matthias, and Andreas K. Engel. "Cognitive functions of gamma-band activity: memory match and utilization." *TRENDS in Cognitive Sciences,* 2004: 347-EOA.

Izhikevich, Eugene M. *Dynamical Systems in Neuroscience: The Geometry of Excitability and Bursting.* MIT Press, 2007.

Tidman, Paul, and Howard Kahane. *Logic and Philosophy: A Modern Introduction 9th ed.* Belmont: Thomson, Wadsworth, 2003.