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An AVATAR a Character

Ana Lilia LAUREANO-CRUCES[1,2], Diego Leonardo FRAUSTO-TAMAYO[2], Martha MORA-TORRES[1,2], Javier RAMÍREZ-RODRÍGUEZ[1,2] and Daniel ARZATE-FLORES[2]

[1] Departamento de Sistemas, Universidad Autónoma Metropolitana-Unidad Azcapotzalco
Mexico City, México, 02200
{clc,mmt,jararo}@azc.uam.mx

[2] Posgrado de Optimización, Universidad Autónoma Metropolitana-Unidad Azcapotzalco
Mexico City, México, 02200
tamayodiego512@gmail.com; da.fd@live.com

Abstract

In the following work the analysis of a behavior thinking of a character is developed. The latter will be represented by an avatar; having human-like behavioral characteristics. From the perspective of artificial intelligence, the evolution and design of an avatar will take place in two directions: 1) bringing its physique closer to humans, or 2) creating more complex, sophisticated and intelligent behaviors. In this work the analysis and design of a behavior located in a specific context and character is developed. Emotions are considered as triggers for actions. Where actions belong to the limited domain of behavior.

Keywords: *artificial intelligence, synthetic emotions, virtual agents, affective computing, cognitive model.*

1. Introduction

In this document the behavior of **Captain America** is modeled; using psychology and cognitive engineering tools.

Artificial intelligence (AI) is a scientific field of computer science that focuses on creating programs and mechanisms that can simulate behaviors considered intelligent. In other words, AI is the field that simulates human behaviors. AI has been in our imagination and in our labs since 1956, when a group of scientists started the Artificial Intelligence research project at Dartmouth College in the United States.

At the beginning of the project, the goal was that human intelligence could be described so precisely that a machine would be able to simulate it. This concept was also known as generic AI; being this idea the one that fueled the (amazing) science fiction that has given us unlimited entertainment.

However, AI drifted into specific fields. Over time, science evolved into specific areas of knowledge, and it was then that AI began to generate significant results in our lives. It was a combination of image recognition, language processing, neural networks, and auto mechanics that made an autonomous vehicle possible. Table1, shows some important events in the history of AI.

Table 1. Events in the history of AI.

Year	Event
1842	Lovelace: programmable analytical machine
1950	Turing: the Turing test
1956	McCarthy, Minsky, Rochester and Shannon host first AI conference
1965	Weizenbaum: "ELIZA", the first specialist system.
1993	Horswill: "Polly" (behavior-based robotics)
2005	TiVo: recommendation technology
2011	Apple, Google and Microsoft: mobile recommendation apps
2013	Miscellaneous: technological advances in automatic and deep learning
2016	Google DeepMind: AlphaGo Beats Lee Sedol in Go Game

The structure of this work is as follows. In *section two* a brief explanation of what cognitive engineering means and the difference between possibility and probability is given. In *section three*, the theoretical framework on which this work rests is explained. In *section four* it is explained what an avatar is and its characteristics. In *section five*, an explanation of emotions and their role in the decision-making process is given. In *section six*, a short biography is addressed that describes life and personality of the superhero. Considering the above, the cognitive model is developed. In *section seven*, the cognitive-affective structure is developed, considering elements of behavior and emotions. In *section eight*, behavior is formalized by developing a causal matrix that is finally represented with a fuzzy cognitive map. In *section nine*, the results of four input vectors are analyzed, to finally reach *section ten* of conclusions.

2. Cognitive engineering

It is a multidisciplinary discipline that emerged in the early 1980s and deals with the analysis, design and evaluation of complex systems that involve people and technologies. They combine knowledge and experiences from cognitive science, human factors, human-computer interaction, and control systems engineering [1,2,3].

2.1. Probability and possibility theory

Probability and possibility are terms that are often used synonymously. However, they are different terms whose meaning should not be used in the same way. The probability comes from the Latin *probabilĭtas* which means *can happen*. Probability refers to an event that can happen, based on evidence or reasons that support the feasibility of said event happening or not. Therefore, it is said that the probability is based on tests, therefore, the possibility of the event happening is greater.

The possibility comes from the Latin *possibilĭtas* that refers to the faculty of something to exist or not. It is a potentiality in which the different changes that can occur during the development of an ongoing situation are expressed. From there it follows that the possible is any event that can occur and is based on hypotheses or assumptions that may or may not occur in a situation or case, but which is not necessarily probable.

Therefore, according to the given definitions, we can point out that probability is based on tests, while possibility is based on hypotheses and assumptions. Probability speaks of the feasibility of something happening, while possibility speaks of the potential for something to happen. Therefore, we can say that, -for something to be probable it must first be possible, while for something to be possible it is not necessarily probable.

Under the previous context, what is required to create an artificial behavior is a cognitive model that allows the behavior to be portrayed. Where the latter can be that of a: 1) character for a video game, 2) avatar, or 3) physical phenomenon; with emphasis on the behaviors of intelligent interfaces that allow a certain degree of personalization by including emotions as part of the information received and taken into consideration to achieve a better decision-making process [4].

3. Theoretical framework

Around the year 2000, various researchers such as: Rosalind Picard, Donald Norman, Minsky, Ortony, Clore and Collins and Igor Aleksander, among others, founded what is known as affective computing. The latter is a sub-line of artificial intelligence (AI) research.

The main objective of AI is to emulate human behavior, be it cognitive or physical. With the help of cognitive psychology (CP). A more formal definition is given in the next paragraph.

AI is the simulation of human intelligence in a machine, in such a way that the machine is efficient in the process of identifying and using the correct piece of knowledge in a certain step related to solving a problem.

Regarding affective computing, it is one that relates the excitations deliberately caused to influence the user's emotions; being a field studied by psychology and its importance in the behavior of a human being. It has two aspects:

1. synthetic emotions

2. eliciting human emotions

The first current implies the ability of a device to reproduce emotions according to the context of the user [5]. For example: a video game, or a second life, among others.

In the second current, what is important is to know what the emotions experienced by a user may be at a certain moment, this implies predicting them. The foregoing in order to have a richer and more contextualized interaction. For example, an ATM that detects the user's needs, a pedagogical agent that detects the student's mood, among others; emphasizing that this current is limited to cognitive emotions, leaving aside those produced by the physiological system.

To achieve this, mathematical models are always used, which treat the data considering the uncertainty, the latter occurs when: a) there is imprecision in the data, or b) there are insufficient data to be able to reason with them.

In addition, there are specific theories to develop behavioral models that come from CP and which allow us to model behaviors.

CP, was born the same year as AI, in 1956, three months apart and this branch of psychology is in charge of understanding the different cognitive behaviors (any process that takes place in the brain); In this way, proposing different tools and models, which can be used by computer scientists, in order to simulate the behaviors of human beings. In the case study we will use Mental Models, cognitive task analysis and a genetic graph.

4. Avatar an autonomous agent

An agent is something that acts. The word agent came from Latin and means agere (willing to do). Computational agents are expected to have other attributes that distinguish them from only programs [6,7].

The characteristics of an agent are: 1) operate an autonomous control, 2) perceive their environment, 3) persistence (long periods of time), 4) adaptation to changes, 5) be able to modify their objectives.

A virtual agent consists of two components: 1) the cognitive one that handles the high-level cognitive processing and 2) the one that handles the detection engine [8]. The cognitive component: interprets the state of the virtual or real world, carries out plans to achieve objectives and makes decisions regarding actions. The sensing engine component enables the cognitive component to perceive the state of the virtual / real world and cause changes in it. In order to achieve the above: 1) the stimulus must be transferred to an internal representation, 2) the representation is manipulated by a cognitive process that leads to new representations, and 3) then there is a return to the world through an action. [7,9-11].

5. Emotions

Although it is difficult to try to find words and definitions due to the way it is used colloquially, that is, to express everything. It is about narrowing down the term. We understand that affective and emotional are used indifferently, although according to psychology, emotion is the last expression of affection [8].

We will begin by giving a definition of what an emotion [11].

"Emotion is an episode of synchronized and interrelated changes in the states of all or most of the subsystems in response to the evaluation of an external or internal stimulus that is relevant to important aspects of the organism."

On the other hand, there is the *sentic* adjective, coming from the Latin *sensus* and the root of the word's *sentiment and sentience*. The latter is generally used to refer exclusively to sensory stimuli [5].

According to Picard [12] an emotional state refers to the internal dynamics when one has an emotion. This state is multivariate and includes aspects of the mental and physical state. It changes over time and with a variety of conditioning factors (internal and external).

An emotion cannot be directly observed (it is proprioceptive, like colors) by another person; but it can be guessed due to the observation and analysis of certain physiological aspects and the narrowing down of a cognitive structure of emotions centered and located within a specific context such as preparing for a sports competition.

In this way, an emotional expression refers to everything that we consciously perceive of our emotional state; related to internal and external events.

On the other hand, a mental state will refer to a longer lasting state. So according to the above, emotional expression or emotions will be used to describe what is indicated to others voluntarily such as a smile or a body expression that implies an action, or involuntary such as a grimace or facial expression. Before a certain event.

Within the work developed by the group for the development of the cognitive model, a theory of emotions is used that belongs to the classification of models based on their components; The framework is based on OCC theory [13,14]. The latter widely used in our projects [15-16, 17].

6. Analysis and Design of behavior

Captain Steven *Steve*; Grant Rogers is a World War II veteran who became the world's first superhero. After the secret Super Soldier program transformed the frail Steven Rogers into the mighty and heroic Captain America, his incredible exploits in WWII made him a living legend. Rogers helped the Allies win the war by attacking various HYDRA facilities with the Howling Commandos, including his best friend James Barnes, much to Johann Schmidt's dismay. After maintaining a relationship with Margaret Carter, and losing Barnes in the capture of Arnim Zola, Rogers managed to defeat Schmidt, but crashed in the Arctic during his last mission. When his body was found, Rogers woke up in the present day, having been frozen for almost 67 years.

6.1. Mental Model

A mental model represents the algorithm of the behavior to follow which has to be linked to the dynamic stimuli of the environment within the specific context.

Next, the emotions, attributes and abilities to model the behavior of Captain America, through mental models are presented. Emphasizing that the **goal and context of the behavior is: Stop Loki.**

Emotions: 1) security, 2) fear, 3) sadness, 4) joy, 5) anger, 6) tranquility.

Attributes: 1) Attack Power, 2) Agility, 3) Disease Immunity = True, 4) Stealth Mode = False, 5) Speed, 6) Threat, 7) Shield Status, 8) Shooting.

Mental Models: 1) main behavior 2) handle weapons, 3) fight, 4) protect oneself, 5) investigate, 6) capture, 7) infiltrate, 8) lead.

6.1.1. Mental models

1. Mental Model of the **Main Behavior**

```
WHILE ( StateLoki == not defeated)
        IF (Threat == true)
            IF (WeaponsAvailable== true)
                HandleArmament(weaponAvailable)
            ELSE
                Fight || Protect yourself
            END_IF
        END_IF
        report=investigate
        ActivMission=true
        CASE (report-type)
        CASE "Enemy in condition of capture": to capture
        CASE "Enemy hidden in fortress": to infiltrate
        CASE "Team present": to lead
        END_CASE
    END_WHILE
```

2. Mental model of the sub-behavior **HandlingArmamen**

```
CASE (WeaponAvailable)
    CASE LightGun:
        Agility=High
        Attack Power=Low
        Shot=quick
        Execut attack
    CASE Rifle:
        Agility=Medium
        Attack Power=Medium
        Shot=fast
        Execute attack
    CASE War Tank:
        Agility=Low
        Attack power=High
        Shot=Slow
        Execut attack
    CASE Hammer Mjölnir:
        Agilility=High
        Attack Power= Very High.
        Shot= infinite
        Execute attack
  END  CASE
```

3. Mental model of the sub-behavior **to Fight**

```
a=GeneratesRandomValue in {0,1,2,3}
    CASE (a)
        CASE 0:
            ShieldSatatus=Launchmode
            Execute shield attack
        CASE 1:
            execute punch
        CASE 2:
            execute kick
        CASE 3:
            execute headbutt
    END_CASE
```

4. Mental model of the sub-behavior **to Protect oneself**

```
ShieldStatus=Protectmode
Cover with shield
```

5. Mental model of the sub-behavior **Investigate**

```
report += searching for clues
    report += visit suspicious places
    IF (report== incomplete)
        investigate
    ELSE
        return(report)
    END_IF
```

6. Mental model of the sub-behavior **Capture**

```
WHILE (TargetPosition==not reached)
        Stealt mode= true
        IF (Enemy in Sight==true)
            to hide oneself || to avoid
        ELSE
            target += continue.
        END_IF
    END_WHILE
```

7. Mental model of the sub-behavior **Infiltrate**

```
IF (EnemyStatus==Weak)
    immobilize
ELSE
    Fight
    Captur
END_IF
```

8. Mental model of the sub-behavior **to Lead**

Split the work
Assign work according to qualities
Fight

6.2. Behavior Cognitive Task Analysis

The Behavior Cognitive Task Analysis (c, is a tool of cognitive psychology that allows us to make an analysis and design of behaviors in order to simulate and encapsulate them in robot, agents, or software. These behaviors are analyzed and separated into increasingly simple layers. This result is perfect for the theory of a reactive agent that builds complex behaviors, based on simpler behaviors.

For this project, the mental models of Captain America were taken as a basis and the BCTA was carried out. The main tasks are obtained from each mental model and it is analyzed whether their content is factual, strategic or procedural.

Subsequently, a recursive decomposition of the main tasks is made into sub-tasks from which information is obtained on what are the necessary skills and the necessary knowledge to carry them out. Tables 2 and 3 show the details.

Table 2. Behavior Cognitive Task Analysis.

Step development	Step contents	Representation type	Complexity of the underlying processes
Loki not yet caught	Factual	Structures	Generalization
There is a threat	Factual	Structures	Simple discrimination
Mission is active	Factual	Structures	Simple discrimination
Use of available weapons	Procedural	Process	Simple discrimination
Fight/Protect	Procedural	Processes	Solving high-complexity problems
Capture	Procedural and tactical	Processes	Solving high-complexity problems
Infiltrate	Procedural and tactical	Processes	Solving high-complexity problems
Lead	Procedural and tactical	Process	Solving high-complexity problems

Table 3. Behavior Cognitive Task Analysis - Skills.

Skills	Knowledge required	Conceptual representation
Pattern recognition	Recognition of events and situations	Ste1, Step2, Step3
Perceptual and tactical engine	Knowledge about weaponry, fighting techniques	Step 2.1, Step 2.2, Step 2.3
Strategic and tactical	Stealth abilities, lead, strategy, knowledge of team skills and powers	Step 3.1, Step 3.2, Step 3.3

6.3. Genetic graph

Genetic graphs (GG) are a way of representing knowledge. The concepts that represent knowledge of any kind are grouped into islands and are related to different types of connections between them. GGs have been used in different contexts, related to the design of behaviors.

In order to more clearly visualize the way in which the knowledge of Captain America is structured, a genetic graph was made that uses different types of connections; There is also a distinction between the different types of knowledge used, and these can be of three types: action, procedure, factual. The above is represented in Figure 1. Considering the previous definitions on the genetic graphs and taking as a base the mental models, and the BCTA, the genetic graphs are developed that are shown in Figure 1;

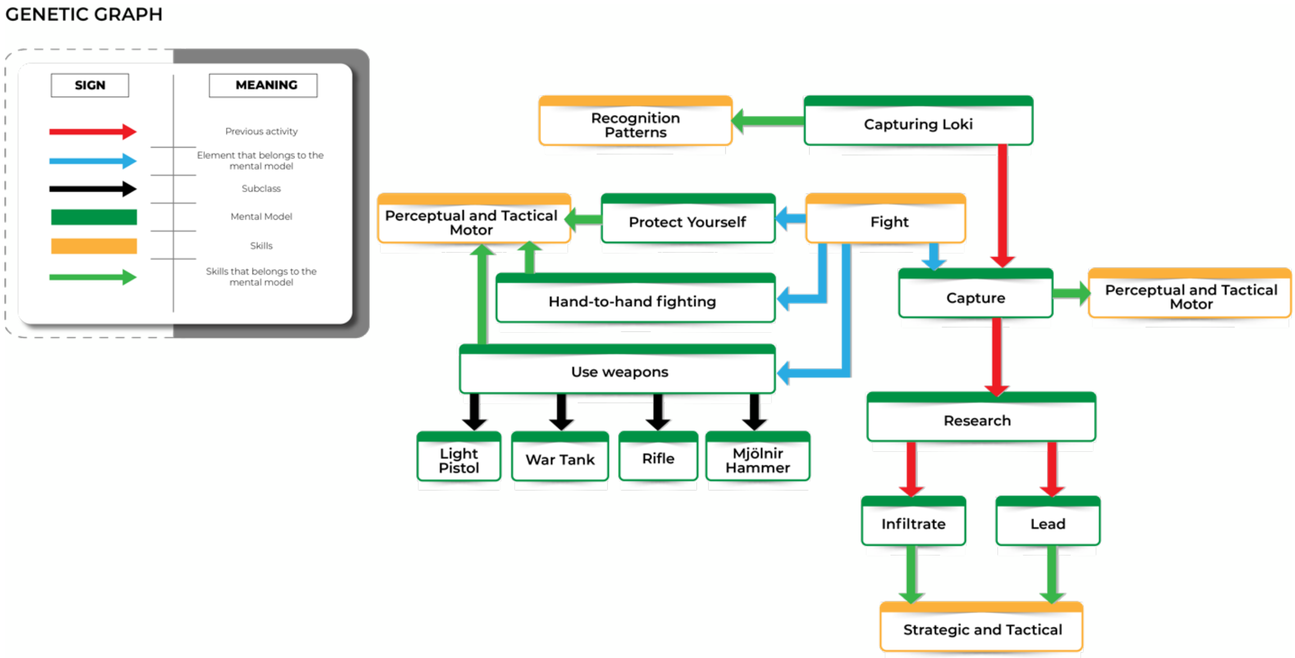

Figure 1. Genetic graph; infographic of the different elements of the cognitive model.

7. Cognitive-affective structure

7.1. OCC theory

The OCC theory; named after its authors: Ortony, Clore and Collins, is an effort to propose an order where there is apparent chaos. An order that allows computer scientists to reproduce an emotion from a general structure in which it is specified that there are three major classes of emotions [13]; each of which starts from the three highlights of the world: 1) events and their consequences; 2) agents and their actions; and 3) pure and simple objects [18].

The three great classes of emotions are:

- *Emotions based on events:* they elaborate consequences for desirable or undesirable events regarding goals.
- *Attribution emotions:* attribute responsibility to agents for their actions based on rules.
- *Emotions of attraction:* based on attitudes towards objects.

In the understanding that all people have different goals that they want to achieve in their lives; these take shape through an cognitive-affective structure; which allows us to achieve our objectives in different contexts, through those goals; one of them being the main one and the others being a set of instrumental goals that allow us to achieve the main goals; next, a brief explanation is given, for more depth consult the related reference.

Starting from the previous assumption, and in order to evaluate the environment, a series of variables are linked in parallel to the structure to be able to measure the impact of the events in the environment on the internal state of the cognitive-affective structure. To achieve this, local and global variables are established that modify the intensity of emotions. As a result, the affects (cognitive elaboration of an emotion) linked to said emotions are presented [14]. OCC proposes a hierarchical structure composed of a higher goal (general) and sub-goals called instrumental goals (more specific). Goals have two defining characteristics (not always present): 1) the kinds of things that can be pursued and 2) the kinds of things that can be achieved with a plan.

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The goals are of different kinds: 1) of active goal (AG); that one wishes to have made, 2) of interest target (IT); that one wishes to happen, and 3) Backfill Goal (BG); They are cyclical, which is why even when they are fulfilled, they are not abandoned. The previous goals are related to the specific objectives within the behavioral context such as: achievement (they achieve certain things), satisfaction (satisfy biological needs), entertainment (enjoy), preservation (preserve states), crisis (manage crisis when those of preservation are threatened), instrumental (they carry out other goals).

These goals are related to each other with links defined as: **n**ecessary, **e**nough, **f**acilitating or **i**nhibiting. For more details consult the related reference.

According to the methodology proposed by Laureano-Cruces [9, 19-20] the elements that make up the behavior including emotions have been chosen to later elaborate a causal matrix, which allows relating the different component elements of behavior.

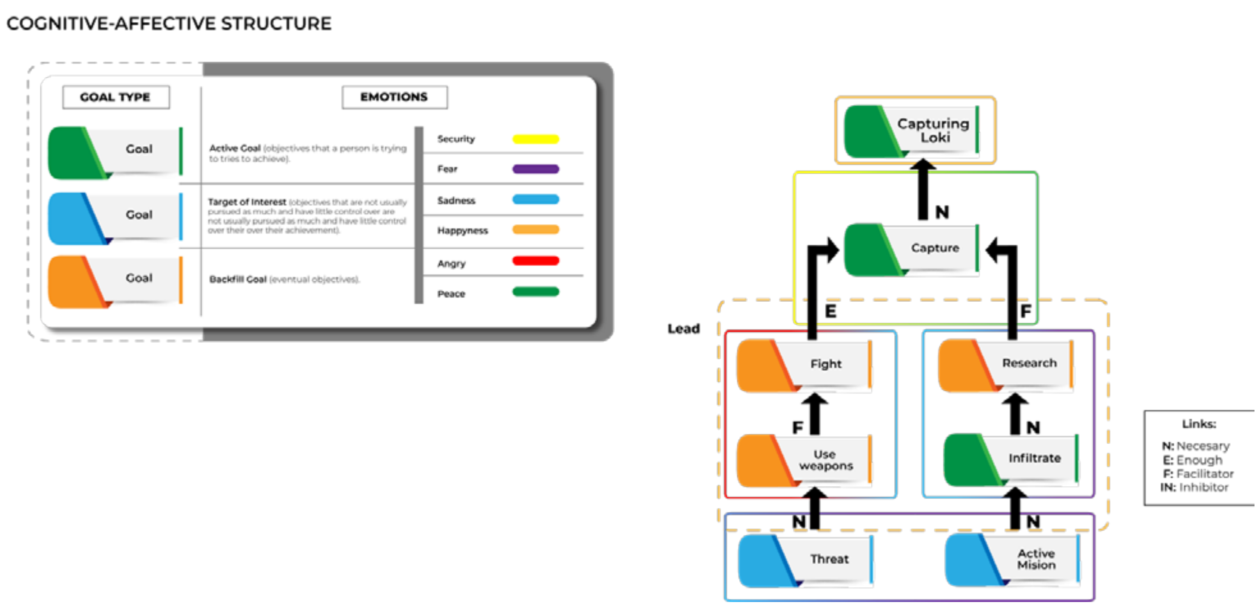

Figure 2. Cognitive-affective structure of Captain America.

Based on the OCC theory, the cognitive-affective structure represented in Figure 2 is elaborated and corresponds to Captain America's behavior in which emotions will be included, as a result of his interaction with the environment and his goals.

8. Formalization of conduct

Reasoning, in the face of uncertain knowledge of the real world, generates degrees of beliefs, rather than certainties, about the relevant observations made in the real world. The presence of uncertainty radically changes the way decisions are made, that is, an action can be selected or rejected depending not only on the objective but also on the consequences of that decision.

In artificial intelligence (AI), the software that allows simulating reasoning (rational behavior) is called an inference engine.

This research is supported by the framework developed by Laureano-Cruces [9,11] where for the treatment of uncertainty causal matrices are used whose formalization is a fuzzy cognitive map (FCM).

Next, a brief explanation of both is given, not being the central theme of this work; In this work, the FCM represent a tool to be able to model the inference engine of the causal matrix of Captain America's behavior.

8.1. Fuzzy cognitive map

According to Mora-Torres [21], the FCMs are directed graph structures; used to represent causal reasoning; being used to represent the knowledge of an expert.

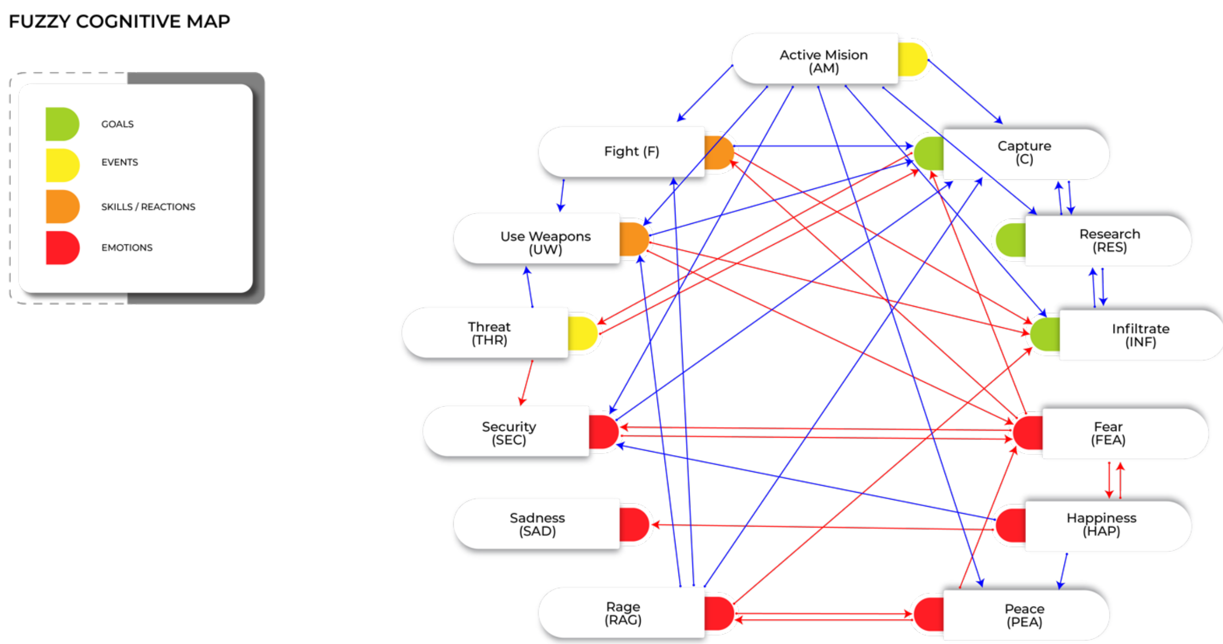

Figure 3. Relationship of the elements that conform the FCM.

FCMs constitute a new approach to modeling the behavior and operation of complex systems. They were introduced by Bart Kosko [22] to describe the behavior of a system in terms of concepts and causal relationships between these concepts. Figure 3, shows the elements chosen for the causal matrix and represented by an FCM.

8.2. Causal matrix

It is through systematicity that a cognitive model manages to represent the causal relationships between the components that make up a cognitive system; the latter manages to simulate reality, adapting to it in relation to objectives. Such simulation is possible because different systems can be arranged to show behavior almost identical to reality. That is, the program is capable of describing in detail the information processing mechanism through which some cognitive function can be implemented. Therefore, a cognitive system must provide a framework that unites the disjecta membra of the fragments and parts of our knowledge, forming a cohesive unit.

A causal matrix is developed to represent the FCMs. Let eij be an arc that describes the causal relationship between the concepts from ci to cj. Table 7, shows the causal matrix.

Let eij be an arc describing the causal relationship between the concepts of ci to cj.

Then:

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eij: 1, if ci causes an increase in cj; directly proportional.

eij: -1, if ci causes decrease to cj; indirectly proportional.

eij: 0, if ci does not involve causality to cj.

Tabla 7. Causal matrix

	C	INV	INF	AM	T	UW	Q	SEC	AFR	SAD	JOY	FUR	TRA
C	0	0	0	0	0	0	0	1	0	0	1	0	1
INV	1	0	1	0	0	0.5	0.5	0	0	0	0	0	1
INF	0	0	0	1	0	-1	-1	-0.5	0.5	0	0	0	0
AM	1	1	1	0	0	0.5	0.5	1	0	0	0	0	1
T	0	0	0	0	0	0.5	1	-0.5	0.5	0	0	0.5	-0.5
UW	0.5	0	0	0	0	0	0	1	-1	0	0	1	0
Q	1	0	0	0	0	0.5	0	0.5	-0.5	0	0	1	-1
SEC	0.5	0.5	0	0	0	0	0	0	-1	0	0	0	0
AFR	-0.5	0	0	0	0	-0.5	-0.5	-1	0	0	-0.5	0	0
SAD	0	0	0	0	0	0	0	0	0	0	-1	0	0
JOY	0	0	0	0	0	0	0	0.5	-0.5	-1	0	-0.5	0.5
FUR	0.5	0	-0.5	0	0	0.5	1	0	0	0	0	0	-1
TRA	0	0	0	0	0	0	0	0.5	-0.5	0	0	-1	0

9. Scenarios interpreted

In the next section we will test various input scenarios; and the outputs will be interpreted.

It is emphasized that the entry scenario is the state of the real world at a given moment and the exit scenario is the possible next state; being interpreted for a possible action according to the evaluated events.

Scenarios to be analyzed:

	C	**INV**	**INF**	**AM**	**T**	**UW**	**Q**	**SEC**	**AFR**	**SAD**	**JOY**	**FUR**	**TRA**
Threat is presented	0	0	0	0	1	0	0	0	0	0	0	0	0
Mission infiltrate	0	1	1	1	0	0	0	1	0	0	0	0	0
CA feels sad and scared	0	0	0	0	0	0	0	0	1	1	-1	0	0
CA feels furious	0	0	0	0	0	0	0	1	0	-1	1	0	0

Vector Result (1). Threat is presented:

C	INV	INF	AM	T	UW	Q	SEC	AFR	SAD	JOY	FUR	TRA
0	0	0	0	1	0	0	0	0	0	0	0	0
0.994	-0.84	-1	-0.99	0	0.999	0.999	1	-1	-0.99	1	1	-1

Interpretation

The entry called *Threat appears* presents favorable results. For condition (1) they favor the chances of capturing the enemy that triggered the threat. The value of the Emotion *Security* activates which matches, while *Fury* increases which also coincides with the activation of *Use of Weaponry and Fight.*

Vector Result (2). Infiltrate Mission:

C	INV	INF	AM	T	UW	Q	SEC	AFR	SAD	JOY	FUR	TRA
0	1	1	1	0	0	0	1	0	0	0	0	0
0.84	0.999	1	0.987	0	-0.99	-0.99	0.971	0.016	-0.99	1	-1	1

Interpretation

The entry called *Infiltration Mission*, presents favorable results, this in opposition to the previous scenario, here the parameters of *fighting and using weapons* collapse, this because the *infiltration* scenario must be cautious and stealthy, the consequent remarkable emotions of this the scenario is *tranquility*, *security* with high values and, on the other hand, *fear and sadness* with low values.

Vector Result (3). CA, feels sad and afraid:

C	INV	INF	AM	T	UW	Q	SEC	AFR	SAD	JOY	FUR	TRA
0	0	0	0	0	0	0	0	1	1	-1	0	0
-0.834	-0.998	-0.999	-0.99	0	0.987	0.988	-0.97	-0.02	0.987	-1	1	-1

The entry called *Captain America feels sadness and fear*, presents negative results, in this the possibility of fulfilling the main goals collapses, despite this, the behavior reflects the ability to face *fear*, and still *fight* and face the enemy, this stage also tends to raise *fury.*

Vector Result (4). CA, feels furious:

C	INV	INF	AM	T	UW	Q	SEC	AFR	SAD	JOY	FUR	TRA
0	0	0	0	0	0	0	1	0	-1	1	0	0
0.82	0.998	0.9999	0.987	0	-0.99	-0.99	0.961	0.048	-0.99	1	-1	1

Interpretation

The results for this entry show positive results, the behavior reflects that *anger* is positive for the fulfillment of Captain America's goals, since it allows to highly activate the possibilities of the main goals. The chances of *fighting* and using weapons decline, which means that Captain America only uses *violence* only in case he feels threatened.

10. Conclusions

The analysis with the provided software has resulted in outputs concordant with the desired behavior to be modeled. With the analysis of the results obtained, we see a clear presence of the duality in propensity of results in which the emotions are integrated in the behavior of Captain America, which is a desired phenomenon, which agrees with our projections from the cognitive analysis of tasks.

The possibility distribution that worked best with our causal matrix was the bipolar logistic distribution, after the inconveniences and misadventures in the analysis with the simple logistic distribution, we had to reconfigure the causal matrix, many times, until we reached the optimal configuration, and it was always the bipolar logistic distribution that best models the phenomenon of Captain America's behavior.

The work carried out has allowed us to model the expected behavior of this fictitious character, through the use of the tools of cognitive engineering theory, the remarkable results of this work reside in the potential of the structures used, although it is impossible (for at least to this day) that these structures allow one by one to describe the behavior and knowledge of a complex agent such as Captain America, if it yields important information about the line of research that seeks this end: to model a consciousness. The model developed allows modeling a limited context, with specific scenarios, but currently there are niches in cognitive engineering in which we can use a behavioral model with such characteristics, such as in the field of robotics and automata, a niche in which there have been large advances in the last 10 years, with the arrival of smart assistants or autonomous vehicles [23], so the study of these structures and tools may be essential for the future of these technologies.

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References

[1] Burden, D., Savin-Baden, M. (2019). Virtual Humans. CRC Press.
[2] Morris, R., Tarassenko, L., Kenward, M. (2006). Cognitive Systems. Elsevier Academic Press.
[3] Konar, A. (2005). Cognitive Engineering. Edit. Springer.
[4] Loewenstein, G., Lerner, J. S. (2003). The role of affect in decision making. In: Davidson, R. J.; Goldsmith, H. H. & Scherer, K. R. (Eds.) Handbook of Affective Science, Series in Affective Science, Oxford University Press, New York:619–642.
[5] Morasso, P., (2007). The Crucial Role of Haptic Perception in Antonio Chella, Ricardo Manzzoti, Ed., Artificial Consciousness, Imprint- academic Press.
[6] Minsky, M., The Emotion Machine, Simon & Schuster Paperbacks, 2006.
[7] Laureano-Cruces, A., de Arriaga-Gómez, F. (2000). Reactive Agent Design for Intelligent Tutoring Systems. Cybernetics and Systems, 31, 1-47.
[8] Aleksander, I. (2005). The World in My Mind, My Mind in the World. IA Press, Iowa City.
[9] Laureano-Cruces, A. L., Rodríguez-García, A. (2012). Design and Implementation of an Educational Virtual Pet Using the OCC Theory. J*ournal of Ambient Intelligence and Humanized Computing*, Vol. 3, No. 1, pp. 61-71.
[10] Laureano-Cruces, A., Hernández-González, D., Mora-Torres, M., Ramírez-Rodríguez, J. (2012). Aplicación de un modelo cognitivo de valoración emotiva a la función de evaluación de tableros de un programa que juega ajedrez. Revista de Matemática: Teoría y Aplicaciones. Volumen 19, No. 2, pp. 211-237.
[11] Laureano-Cruces, A. L., Acevedo-Moreno, D., Mora-Torres, M., Ramírez-Rodríguez, J. (2012). A Reactive Behavior Agent: Including Emotions for a Video Game. J*ournal of Applied Research and Technology,* Vol. 10, No. 5, pp. 651-672.
[12] Picard, R. (1998). *Affective Computing.* MIT, Cambridge.
[13] Ortony, A., Clore, G., Collins, A. (1988). *The Cognitive Structure of Emotions*. Cambridge University Press.
[14] Mora-Torres, M., Laureano-Cruces, A.L., Velasco-Santos, P. (2011). Estructura de las Emociones dentro de un Proceso de Enseñanza-Aprendizaje. Revista Perfiles Educativos-UNAM, XXXIII, 64-79.

[15] Laureano-Cruces, A.L., Hegmann-González, E. (2011). Maze: A Videogame That Adapts to the User's Emotions According to His Behavior. ICGST—Artificial Intelligence Machine Learning Journal, 11, 21-25.

[16] Laureano-Cruces, A., Mora-Torres, M., Ramírez-Rodríguez, J., & Gamboa-Rodríguez, F. (2010). Implementation of an Affective-Motivational Architecture Tied to a Teaching-Learning Process. Proceedings E-Learn 2010 World Conference on E-Learning in Corporate Govermment, Healthcare, & Higher Education, Orlando, 18-22 October, 1930-1938.

[17] Mora-Torres, M., Laureano-Cruces, A.L., Gamboa-Rodríguez, F., Ramírez-Rodríguez, J., Sánchez-Guerrero, L. (2014) An Affective-Motivational Interface for a Pedagogical Agent. International Journal of Intelligence Science, 4, 17-23. http://www.scirp.org/journal/ijis. http://dx.doi.org/10.4236/ijis.2014.41003

[18] Norman, D. A., (2005). *Emotional Design: Why We Love (Or Hate) Everyday Things*. USA: Basic Books.

[19] Laureano-Cruces, A. L., de Arriaga, F., and García-Alegre, M.C. (2001). Cognitive Task Analysis: A proposal to Model Reactive Behaviors. *Journal of Experimental & Theoretical Artificial Intelligence*. Vol. 13, pp. 227-239.

[20] Laureano-Cruces, A.L., Mora-Torres, M., Ramírez-Rodríguez, J., Sánchez-Guerrero, L. & Gamboa-Rodríguez, F. (2014). Assessment of Emotions in an Affective-Motivational Cognitive Model with Fuzzy Cognitive Map. In T. Bastiaens (Ed.), *Proceedings of World Conference on E-Learning* (pp. 1110-1115). New Orleans, LA, USA: Association for the Advancement of Computing in Education (AACE). https://www.learntechlib.org/primary/p/148866/.

[21] Mora-Torres, M. (2007). Sistema Experto en la Toma de Decisiones de un Escenario de Riesgo: LOCA Pequeño en una Planta Nucleoeléctrica. *MSc. thesis, Posgrado en Ciencia e Ingeniería de la Computación*. Universidad Nacional Autónoma de México, 2007. Retrieved from: http://kali.azc.uam.mx/clc/.

[22] Kosko, B., (1992). *Neural Networks and Fuzzy Systems: A Dynamical Systems Approach to Machine Intelligence*. Prentice-Hall.

[23] Ramírez-Laureano, E., Laureano-Cruces, A., Ledo-Mezquita, Flores-Mendoza, C. (2018). Conscious interfaces: a shared responsibility. *IJISET - International Journal of Innovative Science, Engineering & Technology*. Vol. 5 Issue 1, pp- 98-112. January 2018.

Ana Lilia LAUREANO-CRUCES, was born in Mexico City. She obtained a bachelor's degree in Civil Engineering, a Master's degree in Computer Sciences, and a Doctoral degree in Science at UNAM. She has been fulltime professor at Universidad Autónoma Metropolitana since 1989 and guest professor at Universidad Nacional Autónoma de Mexico since 2003. She has more than 70 publications in the field of artificial intelligence. She was a guest researcher between: 1) 1998 and 2000, at the Departamento de Sistemas del Instituto de Automática Industrial del Consejo Superior de Ciencia y Tecnología de Madrid (Spain), 2) September 2011-April 2013 at Université d'Avignon et des Pays de Vaucluse (UAPV, France). Her principal research areas are: Multi-Agent Systems, Intelligent Systems applied to Education, Expert Systems, Knowledge representation, Behavioral Analysis, Affective Computing, Artificial Consciousness.

Diego Leonardo FRAUSTO-TAMAYO, he obtained a bachelor's degree in Computer Engineer and Master´s degree in Optimization from Universidad Autónoma Metropolitana - Azcapotzalco. He actually is working at Indra by Junior Systems Engineer. He has experience mainly in programming languages such as Java, C / C ++. Also worked with other technologies such as Python, Ruby, MySQL, R.

Martha MORA-TORRES, Martha Mora obtained a bachelor's degree in Electronic Engineering at Universidad Autónoma Metropolitana, a Master's degree in Computer Sciences, and a Doctoral degree in Computer an Engineer at UNAM. Her is currently a full-time professor at Universidad Autónoma Metropolitana. Her research interests are: Knowledge Representation, Intelligent Systems applied to Education, Expert Systems, Affective Computing and Artificial consciousness

Javier RAMÍREZ-RODRÍGUEZ, is full Professor in the Departamento de Sistemas at Universidad Autónoma Metropolitana in Mexico City. Doctor, in Mathematics from, Complutense University of Madrid (Spain). He has held lecturing positions at Posgrado de Ingeniería, UNAM and visiting professor at Université d'Avignon et des Pays de Vaucluse, France. His research interests are in exact and heuristics methods, combinatorial optimization and soft computing.

Daniel ARZATE-FLORES, he obtained a a bachelor's degree in industrial engineering and Master´s degree in operations research from Universidad Autónoma Metropolitana. He actually is working at Gamesa-Pepsico at Teyar SA de CV by Construction Safety and Hygiene Supervisor.