

Knowledge organization using shapes extraction from web pages in an auto-adaptive system

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Abstract: Computer Science has always been on a quest for autonomy. Neural networks are quite competitive, however common machines do not satisfy their expectations. Complex systems and auto-adaptive systems are emerging. In this paper a simple shape recognition is combined to a powerful knowledge organization. Here we explain the development of a new type of agent in the Camus and Cardon system: the web agent. This agent is able to extract the images from web pages and will soon be able to associate the extracted shapes to the extracted words from the web pages. This project is developed with the Oz/Mozart system and based on the Camus and Cardon multi-agent system. A new type of agent has been created for this purpose. Experiments are discussed at the end of the paper. The system is able to understand its environment and to make autonomous decisions based on this environment.

Key-Words: auto-adaptive system, multi-agent system, ontology, neural network, knowledge organization, shape recognition, Oz/Mozart

1 Introduction

Neural networks are currently widely used. However without several machines working together, highly performing neural networks can not compete with our computers. Today, artificial intelligence is renewed by a new concept: artificial life. This concept is exploited by complex systems.

In this paper, we study a brand new approach: the combination of simple yet rapid neural networks and a multi-agent system with knowledge organization. This paper gives us too the opportunity to introduce you a new type of agent: the web agent, which combined to the shape recognition will allow more than knowledge organization, knowledge creation.

2 Problem Formulation

In a world in which images have an increasing importance, it is primordial to provide machines the ability to read images. In this way machines become even more autonomous. The encountered problem in other studies is the slowness of the recognition or the lack of semantic interpretation.

This work extends the perception of the environment for the multi-agent system. Here we add one of the main senses: vision.

The purpose of this paper is to see how an auto-adaptive system integrates basic shapes from a visual environment in its knowledge organization and decision-making.

3 Related work

Several papers have already been published on the subject of shape recognition by multi-agent systems. Two directions have been followed: advanced recognition [1] or light recognition with external assistance [2].

In the first case, a powerful neural network is developed in order to interpret information in a real environment. The example of a street intersection is shown. The method used can identify cross walks, road signs, street names and other indications. However to achieve these performances, a learning phase is required. Neural Networks, like humans, learn by example. As stated in the publication [1], the learning time of this system as well as its execution time are usually excessive. Parallel machines are needed for treatment in a reasonable time.

In the second case, basic recognition in a multi-agent system is used. This method is not slow, but the system is totally dependent on human intervention.

Artificial indications are placed in the robot's environment.

In our study, we decided to lean on knowledge organization to simplify the shape recognition. The neural network we implemented is fairly simple. It detects a few shapes such as circles, squares or triangles. The intelligent and auto-adaptive system we use here already has environment cognition. We take advantage of this capacity to perform accurate recognition with a light neural network.

4 An auto-adaptive system

4.1 Multi-agent system

This work uses the auto-adaptive system developed by M. Camus and A. Cardon [3]. This multi-agent system(MAS) is designed to make decisions based on emotions in a non-constant environment. The system contains several agents with different roles. Decision making applied to the environment can be divided into 5 steps:

- **Representation** of the scene including the information coming from the sensors.
- **Attention focused** on elements. This allows operation selection on the data coming from sensors and to increase system treatment.
- **Feelings** based on environmental representation. This level uses morphologic agents to select emotions.
- **Action plan.** Activated agents and emotions create behavior.
- **Reaction to the feedback.** For each action there is feedback, a link between sensors and effectors. This implies an infinite interaction and adaptation between the environment and system behavior.

This is a multi-level representation (figure 1). An entity is not represented by an agent but by several agents. We can recognize a major activation of a role associated to several agents by a high number of messages sent to the linked agents. The system evolves and adapts itself to the environment. This evolution occurs using a systemic loop. The system repeats the same steps in a cycle. As in life, information comes constantly from sensors and are interpreted. Then, actions are made by effectors and taken as inputs by sensors.

In the system, the decision-making level proceeds with parallel information treatment and communication using the same schema that which the human

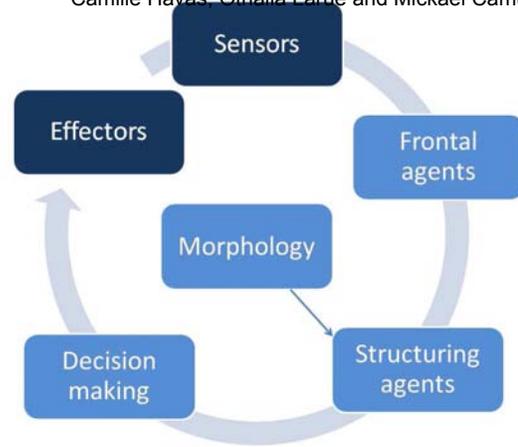


Figure 1: An auto-adaptive system in four steps.

brain uses, as exposed in the Kolb and Whislaw theory [8].

The multi-agent System receives sensor values as input (here, the images). With that information, the system is able to create a scene representation, interpreting the data. Here an image is given as input to the Front agents created for this work(explained in figure 5.2.2 Front agents) in which a neural network generator is embedded.

The Front agents are system agents, containing neural networks and so named because they are placed in front of the other system agents. The decisions and the intentional behavior implied by the image recognition is displayed with a tool: the GNUplot visualizer [12] in which the agents are represented.

4.2 Ontology

In this system, the most important part of all the entities is called structuring agents and each represents a specific word. The ontology we use here is distributed, because knowledge is not gathered in one agent, but shared and interpreted at the same time.

The reason this is emphasized on this type of agent is that they are the decision-makers. Each sensation and thought is understood thanks to knowledge. Without a way of describing and sensing the environment, there is no way of any thought generation. Then there are no decisions made being that decisions are dependent on thoughts and environment.

Disregarding the differences in the knowledge themes, (naturally leading the words to different classifications), we still always use words to communicate and describe what we feel. Thus the machine

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can work the same way. Here is a summary of a classification as seen in [10] of those types:

- Capacities: physical capacities of the hardware entity such as sensors or effectors.
- Objects: simple or composed objects. Example: cube, keyboard, a coat, table. An object in general, a thing according to Heidegger in [11].
- Verbs: verbs in general.
- Colors: basic and mixed colors.
- State: the state of the entity: a strong link with the verb for several elements such as “to tire” or “to sleep”.
- People: persons the entity can remember.
- Space: this section establishes where the entity is located or where it is compared to other specific elements in the ontology.
- Simple emotions: basic emotions such as pleasure or pain as well as many others.
- Mixed emotions: emotions using basic emotions such as love which includes pleasure, joy, pain.

4.2.1 Links

“Scene representation” is the amount of information that the system has been able to capture from its environment. In the case of a robot wanting to play with a ball, the “scene representation” occurs this way :

- **external information reception:** the robot can “see” a ball. Sensors will send messages corresponding to the “ball” knowledge.
- **information activation:** The “ball” structuring agent, matching the messages sent by the sensors, will activate itself i.e. send messages corresponding to all agents related to the ball. A ball is shaped as a sphere, and the two dimensional representation of a sphere is a circle. These two agents are strongly connected in the “ball toward circle” direction. So, the ball will send messages to the circle knowledge.
- **information propagation:** The “circle” agent matches the new messages, so “circle” knowledge is activated too. Since the ball-circle connection is strong, this agent will be very excited too.

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- **information interpretation:** The system “knows” it is a ball : this agent and its related agents are greatly activated, and no other conflicting knowledge suppresses that thought.

Inversely, seeing something round, the “circle” and “ball” agents will be both activated. But, a circle not always being a ball, the circle-ball connection is less strong (has a smaller value) than its opposite. In this case, we can say that the system will “think” of a ball (whose agent will be less excited than if it had seen it), looking for activation of all its related agents to confirm that idea.

4.2.2 New links

New links can also be created during experiments. In earlier experiments, the system played with a pink ball, and “play” is of course linked with “pleasure“, that is why the words “pink”, “play”, “pleasure” will also be activated.

4.2.3 Negative links

Negative links also exist; they allow suppressing entities of opposite concepts. When the ball hits the system’s sensors, it will activate pain. Pain has a negative link with pleasure, so the system will feel less pleasure and will associate, in proportion to the damage done, pain with ball, and even pain with pleasure. It will remember that a ball can cause pain, and that pain can replace pleasure.

4.3 Emotions

Once the agents are activated, the system has the necessary information to determine the action. But as discovered by Bechara, Damasio H, and Damasio A.R. in [1], emotion plays a role in human decision-making. The same applies for this system as the scene representation does not lead directly to decision. Emotions are generated too, which will distort the choice in an unpredictable way [3] .

In the preceding example, we said that, having once been hit by a ball while playing, the “ball” knowledge is from now on linked with the “fear” knowledge. “Fear” being an agent of the “emotion” type, its action will be different from the classic agents. Whatever the decision, it will be encouraged or discouraged by the positive emotions (euphoria, confidence) or negative emotions (fear, awkwardness).

4.4 Morphology to control

In morphology, geometric shapes represent information and phenomenon. The specific morphology (figure 2) in this paper was discovered by Thom [5].

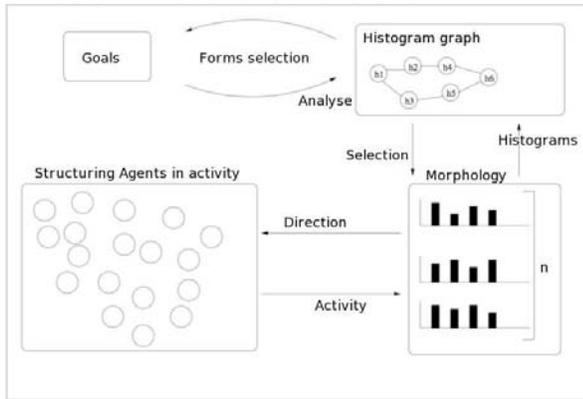


Figure 2: Morphology.

In this system, the morphology occurs when several agents of a system are activated at the same time. This creates a geometrical form. The Campagne model [6] applied to the system is a synchronous adaptation of Thom's morphology. The model we use here is an asynchronous one, developed by M.Camus and A.Cardon [7]. Morphology's goal in the system is to orientate the system to a specific shape in order to match its goals.

In the system, the morphologic agents produce a geometrical shape (histogram) coming from the observation of the communication between the structuring agents during a period. Depending on the situation, the morphology will increase or decrease the prominence of agents. The morphologic agent has a knowledge base with environmental states and there is constant communication between the morphologic agents and the cognition agents.

The knowledge contained in the ontology has a shape associated with the structuring agent's roles. The multi-agent system's organization will depend on the goal. The structuring agents with the correct corresponding role and shape will be activated to match the shape associated to the goal(s) of the system as described in [7].

5 From picture to knowledge

Recognition with a neural network in auto-adaptive system.

5.1 General Features

A new agent type has been created, the Front Agent. Using neural networks, the Front agent is able to determine what shapes are contained in the image. They receive the information (an image) from the sensors

Camille Hayas, Othalia Larue and Mickael Camus and they send words (representing the image) to the structuring agents. If the words sent are part of the ontology, the structuring agents use the acquaintances to activate the related words.

Recognition is basic: circle, triangle, square. However in a contextual ontology, those shapes can be associated to specific objects. For example in the road ontology, a triangle is obviously a road sign.

An association of simple shapes can represent any compound object. For example, in another ontology, a triangle on the top of a square is a house. Depending on the ontology, a little square and a little triangle is a puppet house or a house seen from far away, and a big one is a normal house or a puppet house seen from a very close perspective.

Here we use really simple neural networks which are easy to generate and yield rapid solutions. The neural networks are easily elaborated, and even if they are not sophisticated, combined with the ontology, they give accurate results.

5.2 Achievements

5.2.1 Programming language

We used the Oz/Mozart system [9] to add the Front agent type and the neural network generator to the MAS (already implemented in this language). The Oz/Mozart offers the opportunity to execute a lot of procedures in parallel having a very simple syntax for thread creation. Another particularity is the "Message passing" which simplifies the communication between the neurons of the neural network. The "Message passing" allows sending information from one thread to another. Here this function is employed for the communication between the agents of the MAS and between the neurons of the neural network.

5.2.2 Front agents

This specific type of agent contains Neural Network. They are placed at the beginning of the systemic loop (figure 3). The neural network is a composition of neurons with a specific structure.

Here are the main points of information interpretation: Filter treatment:

- The Canny filter [13] is a basic algorithm deployed for edge detection. When the canny filter is applied to the picture coming from the visual sensors, it will only contain the edges of the objects from the picture.
- Thereafter pixels are filtered by a binary black and white mask

Information transmission:

- The Front agents receive the pretreated picture, and send it as input to the neural network (NN).
- NN is activated on the reception of the message sent by an object of type Neural Constructor.
- A word, corresponding to the output of the NN is sent as the result by the Front agent to activate knowledge.

- NN activation by the NC
- Activation propagation thanks to message passing (figure 5)
- Output generation thanks to message passing (figure 5)

Before each experiment, backtracking is done to balance weights of neural links. The obtained weights are the result of the training period and allow accurate results. They are stocked in a file, to be loaded at each execution.

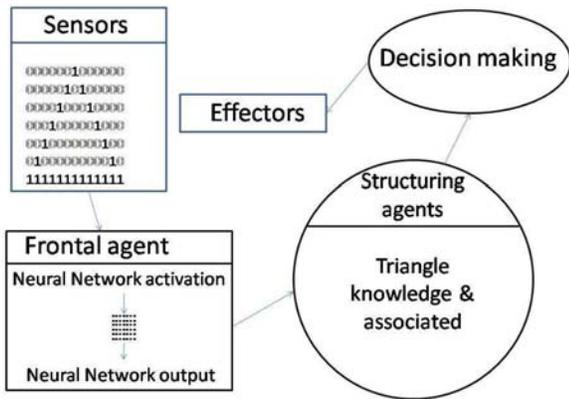


Figure 3: Front Agents' position in the system.

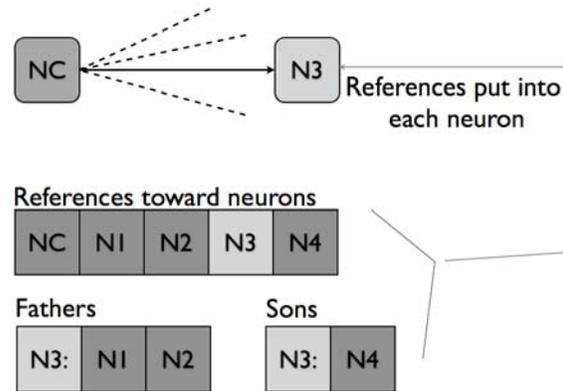


Figure 4: Generic graph formula: (n0:First Neurons; father:sons; last neuron:n0)

This is the graph of this network :(n0:n1,n2; n1:n3; n2:n3; n3:n4; n4:n0)

The Neural Constructor creates each neuron, and initializes some arrays which are essential for the autonomy of the neuron.

5.2.3 Neural network generator

The neural network generator (figure 5) is included in the Neural Constructor (NC) class. The network generation is based on a graph, defined as in the schema. Each neuron is created by the NC. Here is the structure of a neuron:

- An object containing references to all other Neurons (including NC)
- A reading method, which is contained in a new thread to be non-blocking, receiving the input values.
- A variable transfer function, given in parameter.
- A specific weight for each father/son link, defined in the graph.
- A writing method, called only when every father-neuron has sent his output, i.e. this neuron has received all his inputs.

Here are the main points of the network creation:

- Creation of each neuron by the NC, and arrays filling in. (figure 4)

5.2.4 Introducing the WebAgent

In order to parse the web pages, we added a new type of Front agent: the WebAgent. First the Web agent use a XML converter to translate the HTML Web page into XML.

Then using the OZ/Mozart XML Parser, the document is divided in several parts:

- Urls : A list containing the urls of the page using the "href" tag
- Images: A list containing the images of the page using the 'img' tag
- Titles and Paragraphs: the words of the page are treated using "importance coefficient": The coefficients are assigned to the tags depending on the importance of the text in the page: a title has

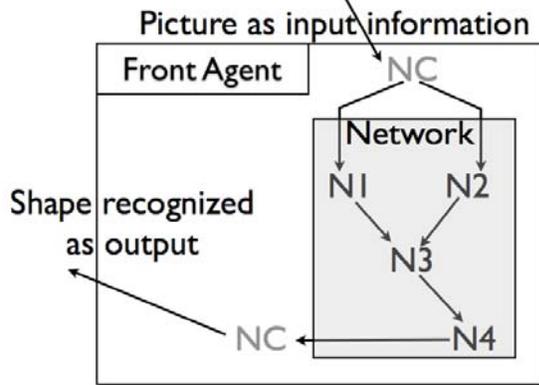


Figure 5: The neural constructor (in gray) receives information, activates the network, and collects the result of the process. The output is a word representing the shape recognized.

a stronger influence than a simple paragraph for the meaning of the text.

Here is an example set of the coefficients used to classify the words:

- title - 4
- h2 - 2
- others - 1

The Images part is the only one in this paper, the others will be used in further development. The Web agent extract the picture from the page and the image will be used for the pattern recognition.

For example for this page 6, the web agent is able to extract the following image list:

In paragraph “Danger”

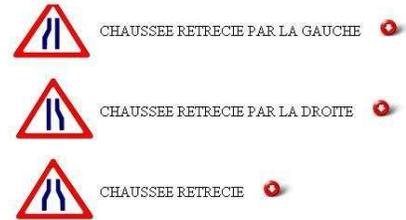
- source=”ap41.gif”:
- source=”ap42.gif”
- source=”ap43.gif”

In paragraph “Interdiction”:

- source=”ap21.gif”
- source=”ap22.gif”
- source=”ap23.gif”



Danger



Interdiction

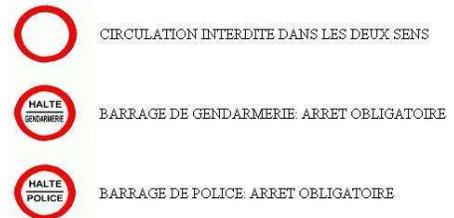


Figure 6: Web page: input for the web agents.

Using the text from the page and the shapes from the pictures, the system will be able to associate words and shapes. We are currently developing the interface which will allow the system to analyze the extracted pictures with the Front Agent.

Thereafter using the knowledge from the web pages, the system will be able to take decisions with different “banners” pictures.

6 Experiment

6.1 First scenario

Features of the scenario:

- knowledge of the environment
- a tiny “road” ontology
- triangular road sign picture (see figure 7) pre-treated with Canny filter (see figure 8).
- gnuplot visualizer
- a Stuttgart Neural Network Simulator (SNNS) build network graph for triangle recognition.

The triangle picture is given as input to the Front agents. The figure 9 shows the result: the “triangle”



Figure 7: Triangle image before the Canny filter treatment.

role is linked to “warning”. Those roles increase the importance of the “fear” emotion shown in figure 10, which leads to the decision “beware”.

6.2 Second scenario

Features of the scenario:

- knowledge of the environment
- a tiny “road” ontology
- road sign picture pretreated with Canny filter
- gnuplot visualizer
- an SNNS build network graph for recognition.

The circle picture is given as input to the Front agents. The figure 11 shows the activation of the “circle” role which is linked to “Forbidden”. Those roles increase the importance of the “frustration” emotion shown in figure 12, which leads to the decision “slow down”.

6.3 Third scenario

Features of the scenario:

- knowledge of the environment
- a tiny “road” ontology
- square road sign picture pretreated with Canny filter
- gnuplot visualizer
- an SNNS build network graph for square recognition.

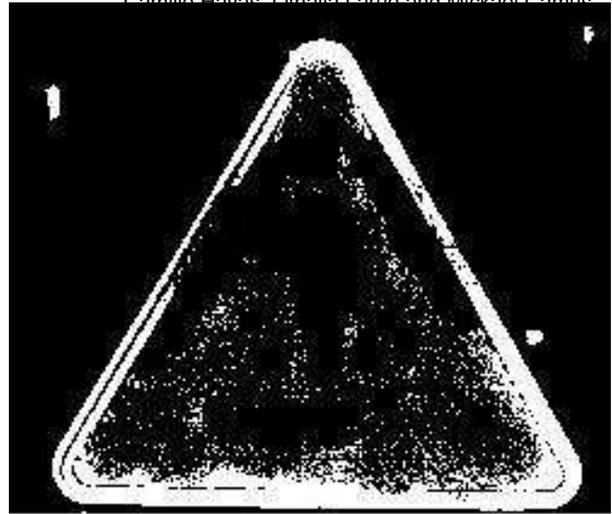


Figure 8: Triangle image after the Canny filter treatment.

The square picture is given as input to the Front agents. The figure 13 shows the activation of the “square” role which is linked to “Authorization”. Those roles increase the importance of the “Happiness” emotion as seen in figure 14, which leads to the decision “Go”.

7 Future development

Picture recognition is a wide subject of research, and a lot of scientists have relevant results on this theme. Although simple recognition is well mastered, it is not really widely used.

Here we put forward two points:

- basic recognition in an auto-adaptive system
- picture research on the web

With the first point, we need a context. If the system is cognizant of the situation, little information like basic shapes present in the picture is sufficient to dispose of an accurate recognition.

With the second point, the user can collect pictures from the web on a particular theme. This research brings the context to the first point.

In future development, the effectiveness of the two points will be put together. The user does a research of pictures on a particular theme. Once the images collected, the theme representing the context, the system can recognize what is depicted.

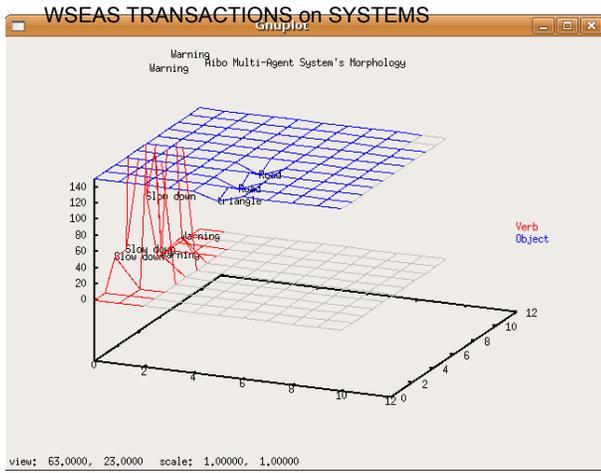


Figure 9: Knowledge representation for “triangle” experiment.

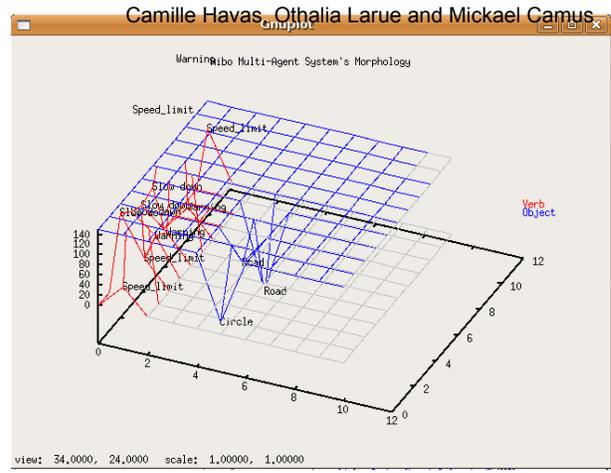


Figure 11: Knowledge representation for “circle” experiment.

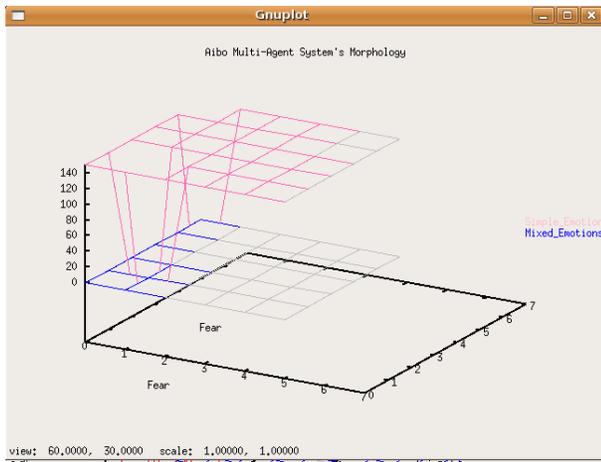


Figure 10: Emotion representation for “triangle” experiment.

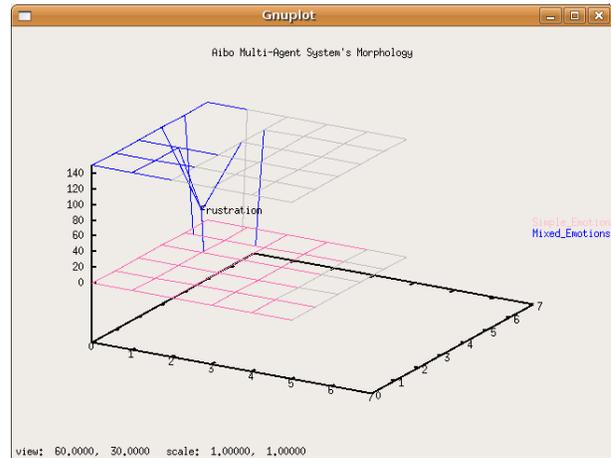


Figure 12: Emotion representation for “circle” experiment.

This combination leads to a picture search engine which can interpret the images' content. In the case of a search for road signs that inform of a danger for instance, a research using the keywords "road sign" must be done (See Figure 15). The system collects pictures of road signs. Here, "Road sign" is the context of the research. The aim of the research is to find pictures representing a "danger". Now the system activates all the knowledge connected with the word "danger". In the case of this theme, danger is represented by triangular road signs. So the system will look for triangles in those images. Once this second research done, the images obtained as result will all represent triangles.(see Figure 16). They are all danger road signs, representing different

dangers. Here we combine two simple functionalities. Simple, but powerful : simple recognition and web pictures collection combined thanks to an AAS, let the system act as a search engine which does research on picture content. This brings the power of pattern recognition within the reach of everyone.

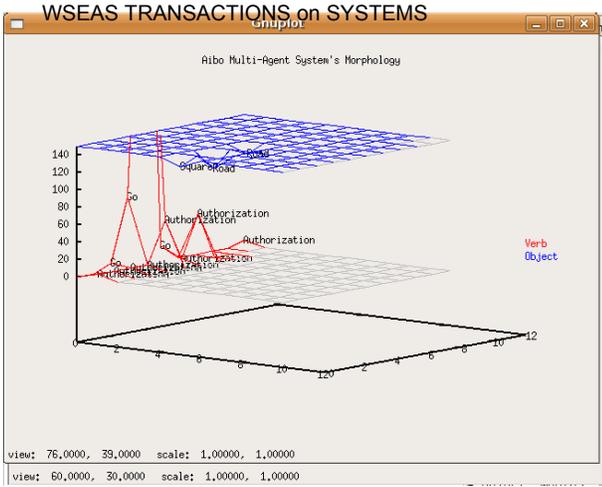


Figure 13: Knowledge representation for “square” experiment.

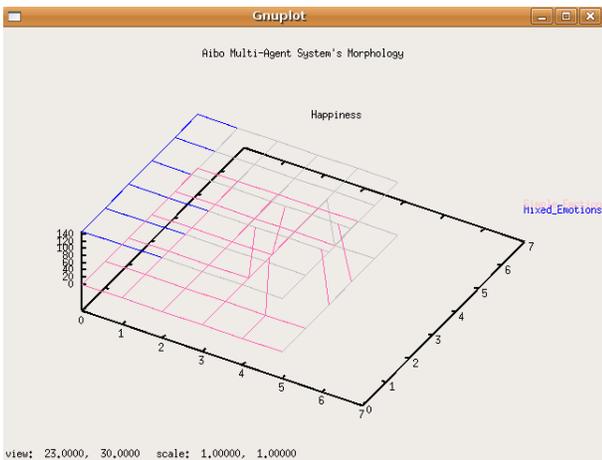


Figure 14: Emotion representation for “square” experiment.

8 Conclusion

Today, a high number of studies have been made separately on the two topics: Neural Networks and Complex Systems. However the papers developing both subjects are rare. We submit a new approach using the interpretation of a multi-agent system with the recognition qualities of a neural network. We also use here a particular module which allows web pictures collection.

For this objective we added a new type of agents to the Camus and Cardon System: the Front agents. This new type of agent is situated at the front of the system, and can have different roles. Using neural networks, a part of the Front Agents



Figure 15: This could be the result for a research using the “road sign” keyword.

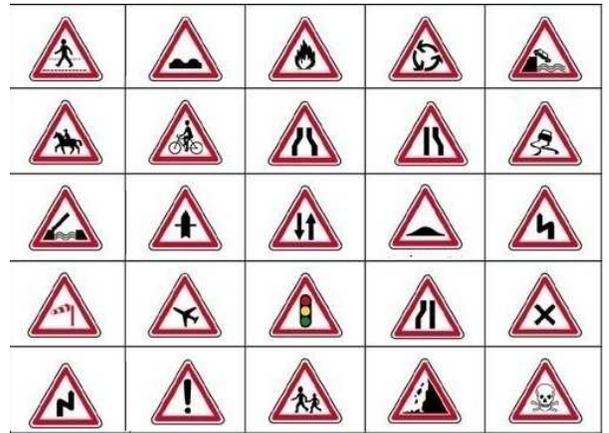


Figure 16: This could be the result for a research for an image representing a danger.

are in charge of recognition. The other part uses web page analysis to infer relevance of the content of the page. They also have to exchange messages within the system. Interpretation is therefore possible.

The purpose of this study is not the creation of elaborated neural networks nor full analysis, but to employ the system to help a basic functionalities (as basic network, or web page analysis). We succeed in this task, letting the system understand the basic meaning of road signs (danger, obligation or interdiction) with basic neural recognition and the knowledge organization of an auto-adaptive system. For further development, we will include more elaborated networks and stronger analysis in the system to improve its abilities.

To reach this goal, the API with definable parameters will facilitate this next step. We can imagine a real time adaptive generation of neural networks or even adapt it to video. Video Surveillance with contextual interpretation is possible. We also imagine

a global search engine which could do research as well on semantic as on the graphical content on the pictures.

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