Sur la programmation de l'intelligence et de l'éthique
On the programming of intelligence and ethics

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Résumé

Cette communication présente un ensemble d'idées à tenir compte dans la programmation d'un système intelligent avec emphase dans la question morale. On analyse les concepts d'intelligence, de règlement automatique, de contrôle, de variable qui poursuit un objectif et de système avec des objectifs hiérarchisés. Il est ébauché, à titre d'exemple, comme on pourrait entamer la conception d'un système intelligent pour contrôler un navire spatial avec quelques suggestions sur comment introduire des normes morales dans ce dernier. On réveille l'inquiétude sur les possibilités qui présentent les idées introduites pour l'amélioration du pilotage de la planète Terre. En synthèse, il est ébauché comme entamer la programmation de l'intelligence et de l'éthique d'un système de contrôle générique et quelques exemples d'application.

Mots clés *: Intelligence ; programmation ; éthique ; contrôle.*

Abstract

This communication presents a set of ideas to consider in the programming of an intelligent system with emphasis in the ethical concern. The concepts of intelligence, automatic regulation, control, goal-seeking variable and, system with hierarchized goals are analyzed. It is outlined, as an instance, the beginning of the way an intelligent system could be designed to control a spaceship with some suggestions on how introducing ethical rules in it. The restlessness awakes on the possibilities that the ideas introduced present for the improvement of the piloting system of the planet Earth. In synthesis, it is outlined how to begin the programming of the intelligence and the ethics of a generic control system with some application cases.

Key words: *Intelligence; programming; ethics; control.*

The intelligence concept

As a starting point, a form to understand intelligence is like the function of the brain or the nervous system. This function controls the good operation of the organism and makes decisions to assure its survival and comfort. According to this all animals are intelligent. However, their intelligences vary according to their way of life (type of feeding, physical characteristics, etc.) and according to the environment. In other words, each animal has the intelligence that needs, like the musculature or the skeleton that needs in agreement with the environment in which it lives, with what it eats and, with its physical characteristics.

The previous concept of intelligence includes, therefore, the automatic processes of regulation. The concept of intelligence can be restricted only to the cerebral functions of reasoning and rational decision making (neocortex) or to be extended excluding solely the automatic regulation processes.

If we try to design an artificial intelligent system (piloting system, robot, computer, etc.) we must start off of goals, environment and restrictions (physical, economic, etc.). In agreement with them, it would be necessary to fix the characteristics of the intelligence that this being needs and also those of its hardware. Possibly it is very difficult if not impossible to design a system that does not include automatic processes of regulation since they are the goals, the environment and the restrictions what condition the design.

Centering on the intelligence understood like the control system of the organism and thinking about that we want to design an artificial intelligence (and a logical-mathematical model of the same before its hardware), we need to specify how we understand the concepts of control, goal, goal-seeking variable and intelligent reasoning.

The basic idea of the control is the intervention on some or all the inputs of a system in order that some outputs are as close as possible to the outputs desired by the controller. For it, obviously, the controller needs to know clearly what is what wishes (goals), to have perfect knowledge of how the outputs are taken place (to have a sensor that provides the value of each variable that represents a goal) and, to have a control mechanism (actuator) to modify certain inputs of the system. These ideas (Caselles, 1994) surround what usually it is called “feedback”, and its origin is in Cybernetics, “science of communication and control in the animal and the machine” according to Wiener (1954, 1975). The word cybernetics comes from the Greek *Κυβερνήτης* that represents the art to pilot a ship and is used by Plato with the sense to lead or to govern people. For that reason control system and piloting system are considered as synonymous.

It agrees to clarify that a certain goal to be well defined either must be measurable (able to take a numerical value which expresses how many times contains to a certain unit of measurement) or, it must be able to be represented by means of a symbol (name) and, it must have a variable in the system (numerical or string) that represents that goal with the same measurement unit or type. For instance, if we want that the temperature of a room (controlled object) is comfortable (target) we must specify more, we must say what temperature we wish (goal-variable) in degrees Celsius (for instance) and to have in the same a thermometer (sensor) that measures the real temperature (goal-seeking variable), also graduated in degrees Celsius. Thus, when we observed that we wished 21º (goal to reach) and have 18º (signal from the environment) we have a deviation of 3 degrees and need to start up a heating mechanism (actuator). This we could do it with a regulating mechanism (personally or automatically through a thermostat), which connects an electrical resistance that warms up the radiator, which warms up the air and which warms up the thermometer. This process is represented graphically in figures 1 and 2. Observe that the diagram of figure 2 admits that, when the desired temperature is not reached in a reasonable length of time or turns out not to be as comfortable as thought, it is wise to modify it (to change the goal). This implies that in the process of regulation of the temperature of the room other mechanisms and other concealed targets can take part (other regulation loops in interaction with the described loop). With this we began to intuit the difference between an automatic regulation process and an intelligent regulation process: this last one reaches a certain level of complexity.

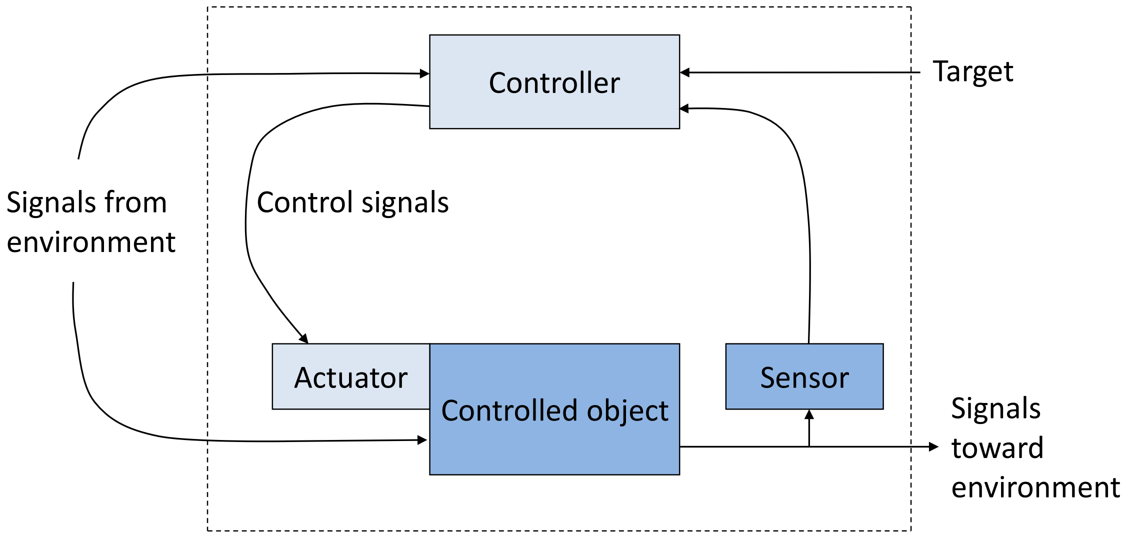

Figure 1. Diagram of a self-controlled system

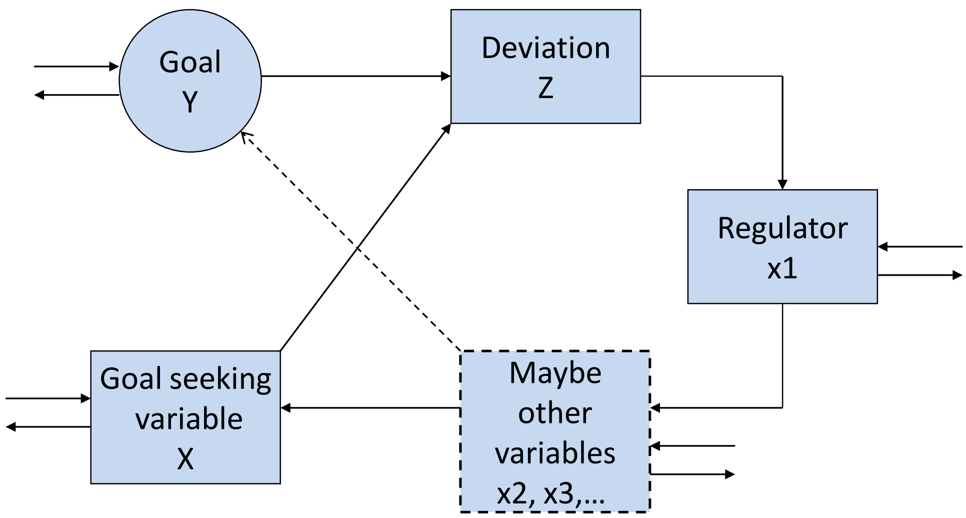

Figure 2. Detail of a control process.

Another one is the classic example of the water tanks: (a) a water tank with an entrance faucet whose level is regulated by a buoy that when rising that faucet closes (simple automatic process) and (b) two communicated water tanks with water entrance to the first tank regulated by a manual faucet, another manual faucet regulating the passage of the liquid of the first tank to the second and a third manual faucet regulating the exit of the second tank. Obviously, process *b* needs the intervention of a person who observes the levels and drives the faucets to maintain the levels stable. However, the activity of this person could be replaced by a more complex automatic regulation process and still it could not be described like intelligent.

We have written about goals, environment, physical characteristics and control. Frequently a goal-seeking system has several goals and, in this case usually they are hierarchized somehow. For instance, according to the psychological theory of Maslow, once the basic necessities are satisfied, the human beings develop higher necessities and desires. First, they are the physiological necessities to maintain the homeostasis: to drink water; to eat; to sleep; to eliminate the remainders. Second, they arise from the necessity that the person must feel safe and protected: physical security; job security; security of income and resources. Third, they are related to the affective development of the individual: association, participation and acceptance. And thus up to six levels. However, the "hierarchy" of the necessities does not imply that all are not considered at the same time. What it happens is that the weight or importance of each necessity varies according to the degree of satisfaction of all necessities. At heart a complex function exists that generates the degree of satisfaction of a global unique goal from the degrees of satisfaction of the partial goals. And now we glimpsed the appearance of a kind of "ethics" in the complex processes of regulation: such ethics gives a form to this complex function that combines all the partial goals. For instance, the form of this function will cause that in an animal species the individual behavior predominates ("if I am hungry and we are only two: I eat you") or the social one ("as we are only two, we are going to lose sovereignty so that what survives is our community"). It is what confronts the necessity to sustain the individual or the species. An individual (man or bird) sacrifices itself (hero) so that the rest of the individuals survive (the case of the bird that attracts the snake and dies in order to save the nest, etc.).

Within systems Literature, the diagram of the "ultra-stable system" of Ashby is specific to represent the systems with goals of different levels. The ultra-stable System is a system with four nested levels of control. These four levels, by subordination order, are denominated: operation level, management level, evolution level and mutation level. In this way, the superior level (mutation) is not subordinated to any other and is the one that determines the goals of the global system. Melèse (1976) does a detailed use of this diagram in problems of management of organizations in general. In this diagram, the physical system and the environment are considered in addition to the goals and the control system. Observe that what this diagram implies is that not only the fulfillment of the goals is controlled but the way to control such fulfillment: the control procedures are included in the system and controlled by other procedures (self-regulated system). This idea is developed by von Foerster (1981, 1991) and gives it the name of "Second-order Cybernetics" or "Complexity Theory" (see Figure 4).

It could seem that we are only dealing with control processes able to become automatic and forgetting the traditional sense of the word intelligence according to the academic dictionaries and the psychological studies. It is not thus. Selecting the characteristic which we considered more excellent among the diverse definitions of dictionaries, thinking that it includes the remaining characteristics, we thought that intelligence could be declared mainly in the "ability to solve *complex* problems". We added the complexity because considering that that ability would already demand or imply the other abilities like understanding, abstract thought, etc. included in the most extensive definitions of intelligence.

Studying the psychological theories on intelligence, for instance, the one of Gardner (1999, 2005) we see that the definition obtained from the dictionaries is explicitly included in one of the seven types of intelligence there considered: the mathematical/logical intelligence. However, we considered that it is implicit in all the types of intelligence that Gardner describes (1. Linguistic/verbal; 2. Corporal/kinetic; 3. Rythmical/musical; 4. Mathematical/logical; 5. Visual/Spatial; 6. Interpersonal; 7. Intrapersonal). Likewise, we consider that a great memory, ability to make rational decisions, learning ability, etc., mentioned by other authors (for instance, Lubart & Georgsdottir, 2004), are necessary and are implicit in the mechanisms to solve complex problems (we assume that a "simple" problem is the one that can be solved with a first order regulation mechanism, that is to say, without nested loops).

An intelligent performance, that implies the resolution of a complex problem, in our opinion, could be modeled with the following diagram of stages:

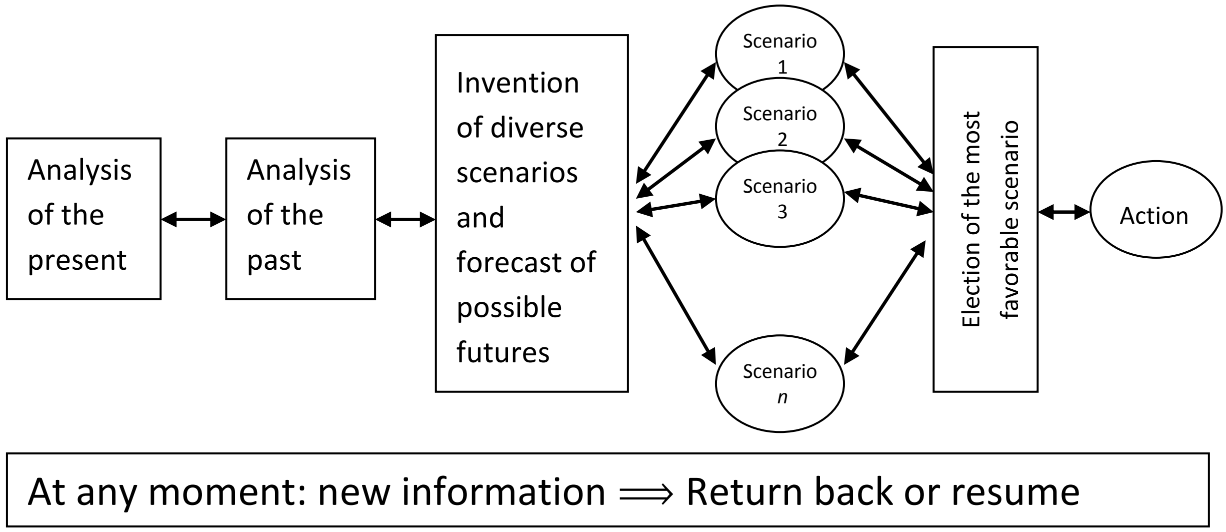

Figure 3. Stages that lead to an intelligent performance

Let us suppose that the beginning of the intelligent action takes place when on an intelligent system (human or not) a stimulus takes place from the outside that causes the incitation to action. The first stage/response corresponds obviously to the observation of the own immediate surroundings (Where am I?); the second stage forces the retrospection (from where come we?, what has happened until today?); the third stage will consist of asking themselves which is the evolution to which the cause that produced the stimulus takes, in agreement with the observed tendencies and all previous knowledge and, consequently, the necessity of a fourth stage raises to imagine which are the scenarios to which each possible answer can lead. Finally, the fifth stage is the evaluation of the different scenarios (necessity to have a valuation criterion) and the comparison among their values will lead to choose an option (sixth stage) that triggers an intelligent performance. Think, for instance, in a chess play.

Let us see of schematic form which the intellectual functions that predominate in each one of the described stages are (Table 1).

Stage	Description	Dominant intellectual function
1	Analysis of the starting situation	Observation ability: understanding
2	Retrospection	Memory
3	Design of scenarios	Imagination
4	Projection	Logical thinking
5	Assessment of scenarios Comparison of their values	Using a scale (moral principles? ethics?)
6	Performance	Will

Table 1. Dominant intellectual functions in the stages of the production of an intelligent performance.

Let us see different examples: One of them could be the intelligent performance of an industrialist to whom the opportunity appears to create a company to make or to distribute a new product in the market; or perhaps the decision of a government to take part in a warlike conflict in which vital interests are jeopardized; or something simpler and personal: to decide how to react faced with democratic political elections. We left to the imagination of each one describing how it would be the succession of stages and its details until culminating with an intelligent action.

Notice that:

- The stages third and fourth imply that the intelligent being is able to construct a mental mathematical/logical model of the behavior of the system that it handles (the relevant elements and their interrelations) and to simulate with it. For instance, the chess player knows the possibilities of each piece on the board and the capacities of his/her opponent, imagines all possible moves and how his/her opponent will react to each one of them.
- The fifth stage entails the disposition of certain criteria for the valuation of the different scenarios, that is to say, “principles”, an “ideology”, a “moral” or an “ethics”. It implies that the intelligent performance, as a starting point, is relative to the validity of that set of valuation criteria. But, how this validity is measured? In order to respond to this question we need a greater order goal that allows us to evaluate the previous valuation criteria and also need rules indicating how to change them when they are demonstrated non-suitable, that is to say, we need learning capacity. Think about the case of the bird that lets itself eat by the snake to save its nest. In this case the greater order goal is the survival of the species as opposed to the individual survival and the learning corresponds to the species. Another question arises next: how is evaluated the validity of those greater order goals and rules? For it, a still greater order goal is needed as well as more rules for change. And so on. Evidently we enter in a complex system or in Cybernetics of second order, third order, etc.

We are going to initiate the application of what the Ashby’s diagram (Figure 4) contains about control or piloting by hierarchical goals and rules to the case of an artificial intelligent system (perhaps a robot), with the purpose of illustrating how it can be applied to other cases (for instance, to the intelligent control of the globalization process that at the moment we live). This diagram condenses a general method to design a piloting system or to improve the piloting of a generic organization. If we are faced with a new system it is about design, if we are faced with a concrete organization and the piloting method that is used at present adapts well to this scheme it will be correct, on the contrary it will have to be modified/improved. At sight of this diagram it is obvious where intelligence resides and where the ethics resides: in the control system, that includes so much the goals as the regulation rules at all the levels of recursion.

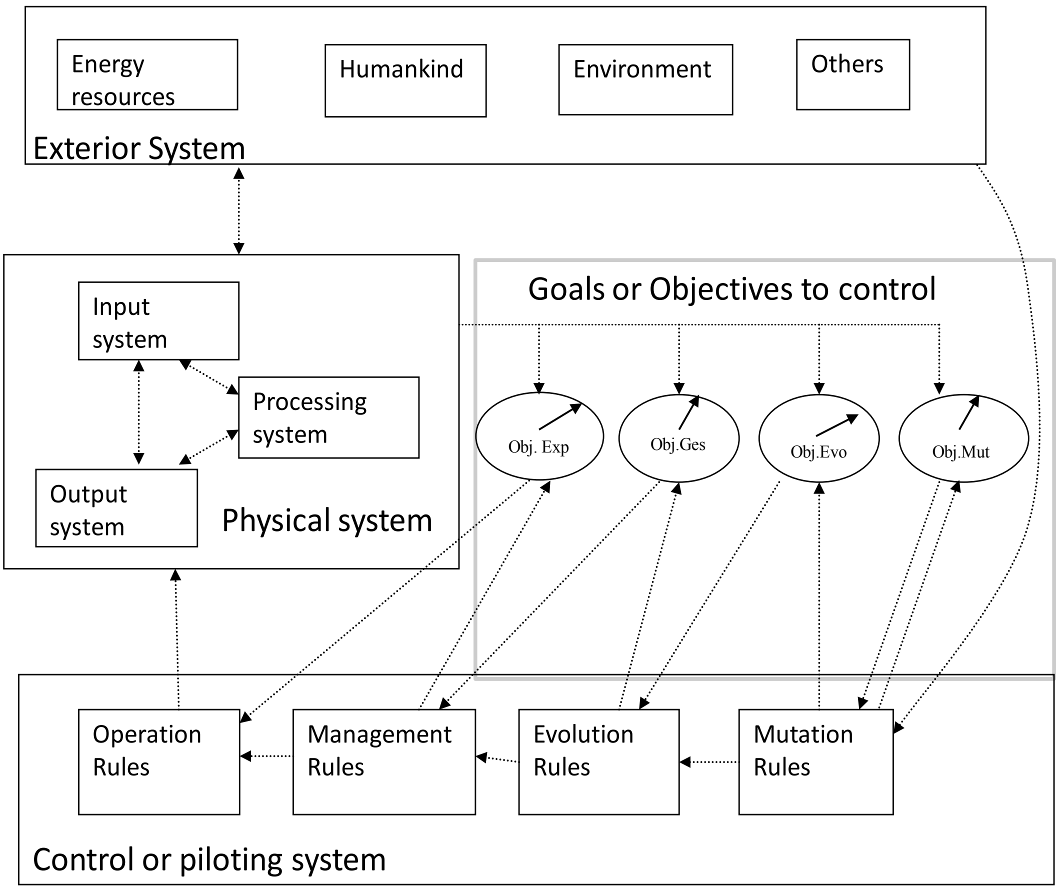

Figure 4. Diagram of the ultra-stable system of Ashby applicable to the case of an intelligent system

A way to understand the sense of the four control levels and its relation with the term to which they act and with the names that usually are assigned to them, is expressed in Table 2.

Control level	Knows:	Determines:	Decides to term:	Its activity is called:
Mutation	Exterior system	Goals	Very long	Politics
Evolution	Goals	Means	Long	Strategy
Management	Goals and Means	Procedures	Middle	Tactic
Operation	Goals, Means and Procedures	Correct performance	Very short or immediate	Execution

Table 2. The control levels in the Ashby's diagram

Initiation to the design of the intelligence and the ethics of a control system

We have seen that a generic control system includes goals and performance rules at several hierarchized or recursive levels, that is to say, subordinated to others. Therefore, firstly what we must do it is to define the goals of greatest level (mutation goals) and the rules for: (a) to modify these according to the changes of the environment and the previous performance of the physical system; (b) to define or to modify the goals of the evolution system according to the degree of fulfillment of the mutation goals; (c) to define or to modify the rules of the evolution system according to the degree of fulfillment of the mutation goals; (d) to define or to modify the rules to change the mutation rules. Next we will proceed of a similar way with the following control levels.

On the goals of maximum level (mutation) of an intelligent control system we can, for instance, to refer to the well-known three principles of robotics of Isaac Asimov that, as well, are hierarchized: (1) Not to damage the human beings neither directly nor indirectly; (2) To obey the human beings when it does not contradict principle 1; (3) To try to secure the own survival when it does not contradict principles 1 and 2. McCauley (2007) makes a detailed study of these principles and their possible appropriateness and applicability that can be very interesting for some readers. In our case we did not consider more detail necessary.

In some cases the goals and rules of mutation may not include these three principles, remember that the robot HAL 9000 of the history of Kubrik/Clark, equipped with the great intelligence, superior to the one of the remaining crew of the spaceship (it wins to them to the chess), has been programmed to carry out the mission (mutation goal) "by any means". That is to say, in the "ethics" of HAL (concretely in the mutation rules) the corresponding rule was "the aim justifies means", or, it was programmed like a completely free being and during its instruction time or learning period (where ethical rules can be inserted to it or to leave it discover them) care was not had in that it learned on the consequences of this rule. Also, reading the novel, it can be deduced that to get rid of all the crew of the ship was HAL's idea (simulating a failure) so that the humans (to those who at heart it considered inferior and to those who it had to obey) could not make difficult its contact with "the superior intelligence" (during the trip it was the unique one that knew that the mission was that).

The mutation goals, in theory, could be modified by the mutation rules and the same can be applied to the mutation rules themselves. For instance, in addition to the previously mentioned (1), (2) and (3) rules, that according to McCauley (2007) could be rewritten, rearranged and completed to get to be more realistic, they could be added, among other many, the following ones: (4) "the mission will be aborted and the ship will be self-destroyed when all possibilities of return and communication with the Earth are lost and is no alive human beings in the ship" (the greater rank goal is switched fire); and (5) "the rules (1), (2), (3) and (5) are immutable" (the appropriateness of this rule also is analyzed by McCauley).

The mutation rules determine the evolution goals. For instance, supposed the mission is well defined, a part of the mutation rules will allow determining the characteristics of the ship, necessities of crew, fuel, foods, spare parts, etc. The mutation rules also determine the evolution rules and how to modify them.

The evolution rules will allow determining the management goals and the management rules. For instance, some rules will determine: (a) how to calculate the consumption, recycling and repairs of the components and crew of the ship throughout the time; (b) how updating these data if circumstances vary; (c) how and in what circumstances to communicate with the Earth control of the mission.

The management rules will allow determining the operation goals and the operation rules. For instance, some management rules will determine: (a) how to let know to the crew and at what moment its obligatory actions; (b) when to perform the predicted operations of maintenance.

The operation rules will allow to determine how to execute all the predicted operations correctly and how to know when a process runs well or when an operation is well made.

Now that we have an outlined way, we are going to take a step more: in view of the special phenomena that are detected at the moment in the world (climatic change, financial crisis, globalization, etc.), could these ideas be applied to the planet Earth considered like a spaceship? Can rather a brain or a nervous system be constructed for the Earth? How would be the Earth brain? Would be the Earth like a great "cyborg", with a partly human and partly artificial brain? (Maybe the *UN* plus computers) Could the present piloting system of the Earth be improved? Which would be its goals of mutation, evolution, etc.? Which would be the rules that allow to control and to modify these goals? If these goals and these rules are not described, is convenient to describe them? What kind of ethical rules is advisable to insert in the different levels of the control system?

Evidently we are not going to answer these questions now. We are satisfied with waking up the corresponding restlessness. However, the works of Warwick (2003, 2010) come to the mind. There the author makes a detailed analysis of the ethical considerations to take into account in the case of a concrete type of "cyborg" (a human with artificial implants in the brain) as well as in the case of a mechanical robot with a biological brain obtained from the culture of human neurons.

In the first case it is added to the capacities of the human brain: (a) the great processing speed and mathematical calculation possibilities; (b) the possibility of extending the sensorial capacities (night vision, ultrasounds, etc.); (c) the capacity to understand more than four dimensions (three space ones plus time); (d) the possibility of communication via Internet and in parallel with other brains and data bases; (e) the extension of the memory. The ethical considerations that Warwick (2003) in this case does refer to: would all human beings have the possibility of becoming a cyborg? And, in case of not having it or not wishing it, would they be like inferior beings at sight of a cyborg? How would be related the ethics of cyborgs to the one of humans? These ethics, obviously, would be different given their different respective necessities. Would the Earth be under the control of a network of intercommunicated cyborgs? Is this a desirable future?

In the second case (nowadays mechanic robots exist with brains made up of 100,000 rat neurons) perhaps a brain with human neurons much greater than the present human brain could (possibly not too distant) someday be cultivated to control very complex organizations. The ethical considerations that Warwick (2010) does refer to in this case are: to what extent it would be conscious of itself? Which rights it would have? The citizenship perhaps? Would be correct that it was only an instrument on hands of scientists? Let us put ourselves in its place. Would be desirable for a scientist to bring to life a being of such characteristics? In what place the humans and the other living beings in a planet governed by a brain of these characteristics and their corresponding nervous system would have left?

Conclusion

A set of ideas to be considered in the programming of an intelligent system with emphasis in the ethical question are presented. The concepts of intelligence, automatic regulation, control, goal-seeking variable and system with hierarchized goals have been reviewed. It has been outlined, as an instance, the application of the Ashby's diagram of the ultra-stable system to the case of an intelligent system controlling a spaceship with some suggestions on how introducing ethical rules in it. Also, the restlessness has awaked on the possibilities of improvement of the piloting system of the planet Earth (idea suggested by the climatic change, the present financial crisis and the present process of globalization) and the ethical considerations that it would entail. In synthesis, it has been outlined a possibility to focus the programming of the intelligence and the ethics of a generic control system with some application instances.

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ESPAÑOL

El concepto de inteligencia y la elaboración de un modelo computerizado de la misma.

En esta comunicación se pretende hacer un análisis de la situación actual y posibilidades que ofrece el concepto de inteligencia que pueda ser utilizado para interpretar el proceso de "pensamiento y acción inteligente" para su utilización en la programación de un ente artificial inteligente (robot):

- Análisis de las etapas componentes del proceso de pensamiento del cerebro humano y propuesta de un modelo sistémico.
- Interpretación y desarrollo de cada una de las etapas.
  - Propuesta provisional de las posibles etapas de la actividad intelectual:

Etapa	Descripción	Función intelectual dominante
1	Análisis de la situación de partida	Capacidad observación: entendimiento
2	Retrospección	Memoria
3	Proyección	Pensamiento lógico
4	Diseño de escenarios	Imaginación
5	Comparación y valoración de escenarios	Disposición de escala (¿principios morales? ¿ética?)
6	Actuación	Voluntad

  - Análisis de la conveniencia de incluir en el modelo otros tipos de capacidades intelectuales y su participación en las siguientes actuaciones intelectuales, intentando responder a las siguientes preguntas:
    ¿La inteligencia incluye las capacidades sensoriales?
    ¿La inteligencia incluye las capacidades motoras?
    ¿La inteligencia incluye las capacidades de adaptación?
    ¿La inteligencia incluye las habilidades para la reproducción?
    etc.
    ¿Estamos queriendo diseñar un ente auxiliar o un ser vivo?
    ¿La selección de la mejor opción que condiciona la acción –etapa 5ª–implica que el programa de comportamiento incluye categorías morales?

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ENGLISH

The concept of intelligence and the elaboration of a computerized model of the same one.

In this communication it is tried to make a situation analysis and possibilities present that the intelligence concept offers that it can be used to interpret the process of "thought and intelligent action" for his use in the programming of an intelligent artificial being (robot):

- Analysis of stages components of the process of thought of the human brain and proposal of a systemic model.
- Interpretation and development of each one of the stages.
    - Provisional proposal of the possible stages of the intellectual activity:

Stage	Description	Dominant intellectual function
1	Analysis of the starting situation	Observation capacity: understanding
2	Retrospection	Memory
3	Projection	Logical thought
4	Designing scenarios	Imagination
5	Comparison and assessment of scenarios	Disposition of scale (moral principles? Ethics?)
6	Performance	Will

    - Analysis of the convenience of including in the model other types of intellectual capacities and its participation in the following intellectual performances, trying to respond to the following questions:
      Intelligence includes the sensorial capacities?
      Intelligence includes the motor capacities?
      Intelligence includes the adaptation capacities?
      Intelligence includes the abilities for the reproduction?
      etc.
      We are wanting to design an auxiliary being or an alive being?
      The selection of the best option than conditions the action - stage 5^{th} - implies that the behavior program includes moral categories?

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FRANÇAIS

Le concept d'intelligence et l'élaboration d'un modèle informatisé de ce qui est même.

Dans cette communication on prétend faire une analyse la situation actuelle et les possibilités qu'offre le concept d'intelligence qui peut être utilisé pour interpréter le processus « pensée et action intelligente » pour son utilisation dans la programmation d'un être artificiel intelligent (robot):

- Analyse des étapes composantes du processus de pensée du cerveau humain et proposition d'un modèle systémique.
- Interprétation et développement de chacune des étapes.
  - Proposition provisoire des possibles étapes de l'activité intellectuelle :

Étape	Description	Fonction intellectuelle dominante
1	Analyse de la situation de partie	Capacité d'observation : entendement
2	Rétrospection	Mémoire
3	Projection	Pensée logique
4	Conception des scenarios	Imagination
5	Comparaison et évaluation des scenarios	Disposition d'échelle (principes moraux ? éthique ?)
6	Activité	Volonté

  - Analyse de la convenance d'inclure dans le modèle d'autres types de capacités intellectuelles et sa participation en les activités intellectuelles suivantes, essayant de répondre aux questions suivantes:
    L'intelligence inclut les capacités sensorielles ?
    L'intelligence inclut les capacités motrices ?
    L'intelligence inclut les capacités d'adaptation ?
    L'intelligence inclut les habilités pour la reproduction ?
    etc.
    Voulons-nous concevoir un être auxiliaire ou un être vivant ?
    La sélection de la meilleure option qui conditionne l'action - étape 5 - implique que le programme de comportement inclut catégories morales ?