

Research Article

# Space of Reasoning of Individual Common Sense in Cognitive Architecture AGICA

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## Abstract

This article examines the problem of forming basic concepts in robots within the framework of the development of Artificial General Intelligence (AGI). The theories of concept formation in infants were reviewed. There is the consensus that in this early period of human cognitive development the basic concepts and reasoning are established that was named “common sense”. In the article common sense will be seen from two perspectives: individual and collective ones. This article is devoted to the formation of individual concepts of common sense in robots. In the set of individual concepts of common sense are being discussed here spatial and temporal conceptual domains prevail. Collective concepts of common sense will be mentioned briefly. In this phase of AGI development the proposed concepts formation procedure means mostly a-priori concepts that are preliminary designed as the software procedures and only “is grounded” in robot. But these “first concepts” create the basis for further learning procedures. As the platform for conceptualization procedure the cognitive architecture AGICA was considered. Cognitive architecture AGICA was represented by the author in 2023 on the base of “axiomatic approach” in AGI development. In cognitive architecture AGICA there were used the models of AGI-Consciousness, AGI-Individual Type, AGI-Collective Type in the framework of “grounded cognition”. AGI-Individual Type is based on “instinct of self-preservation” (survival instinct). AGI-Collective Type is based on “species preservation instinct”. Given that we are now far from a general theory of concepts, the development of transport robots is viewed as an application domain. This article does not claim to be comprehensive and can be viewed as some “engineering approach” for problem solving, - thus it is mostly addressed to the developers. In the main part of the article we will consider only *perceptual/modal/concrete concepts*. *Amodal/abstract concepts* will be out of the discussion.

## Keywords

Artificial General Intelligence (AGI), Cognitive Architecture, Concept, Reasoning, Individual Intelligence, Swarm Intelligence, Operating System, Common Sense

## 1. Foreword

This is not the academic article in format, it is rather some project specification. The article is oriented to the professional auditorium of developers of Artificial General Intelligence (AGI). This article concerns cognitive architecture AGICA that was proposed by the author in 2023 (see [Figure 1](#))

[5, 6]. AGICA is based on the set of definitions of main concepts of AGI the author published for the last decade [1-3]: AGI-Consciousness, AGI-Individual Type, AGI-Collective Type, AGI-Thoughts, AGI-Emotions and some others.

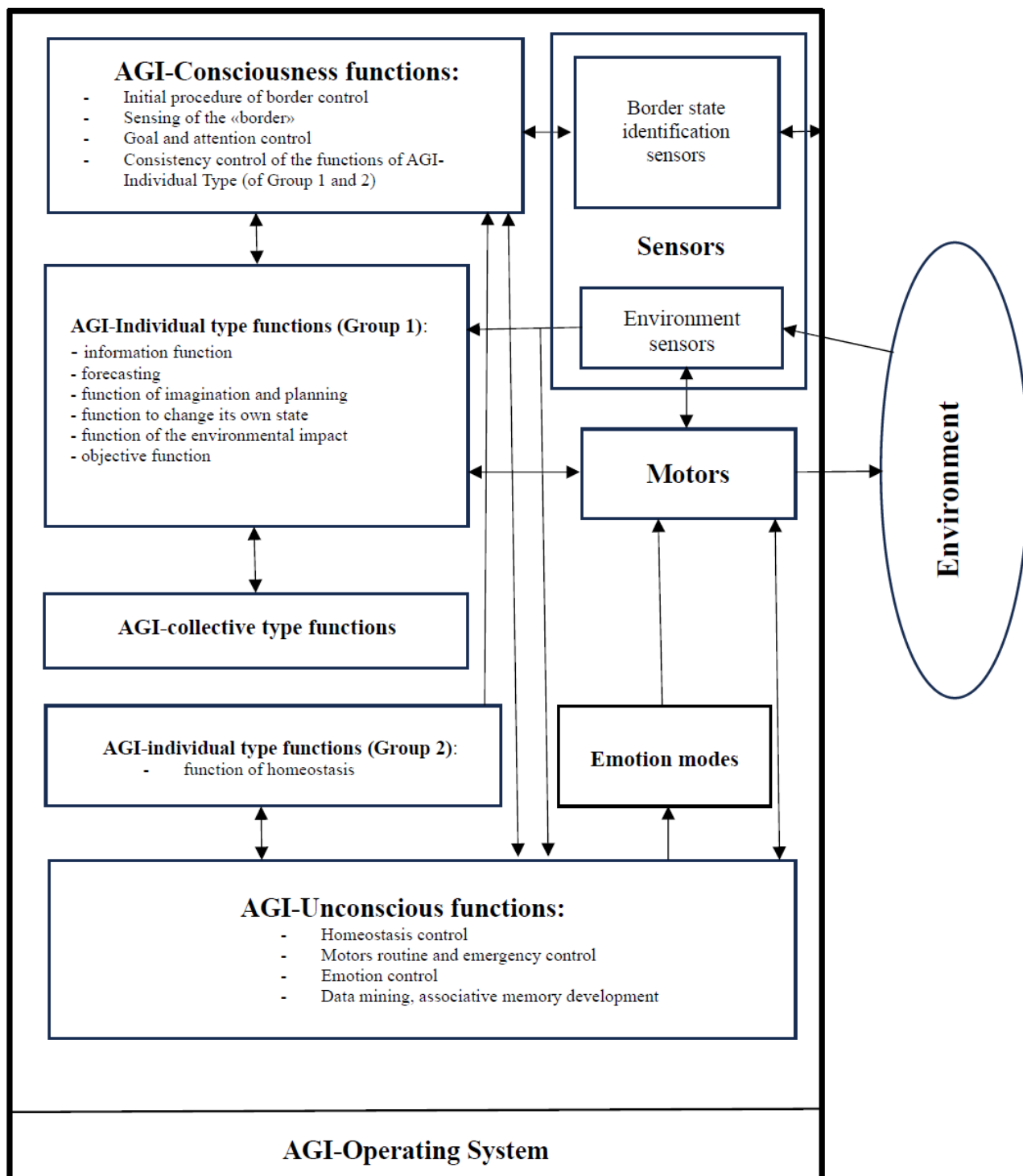
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**Figure 1.** Cognitive Architecture AGICA - functional view.

Cognitive architecture AGICA - this is open engineering project aiming to design AGI-OS - Artificial General Intelligence Operating System - that will be universal for many applications [4]. As the “applications” the author means AGI-robots. The author is sure that AGICA can be designed and implemented nowadays with the technologies and approaches currently available. The author wants to represent here his view how “Space of Reasoning” can be started in

AGI-Agent initially from the establishing of the set of *a-priori* concepts of “Individual Common Sense”. The author pay less attention here to the augmentation, - for core approaches it can be found in referenced author’s articles.

Working AGI for robots is the ultimate goal of development, and as the sub-goal for the first phase of the project, the author is going to model “common sense concepts”.

In this article, the author considers only structural and

functional approaches to the development of AGI-OS. For mentioned reasons, the author will limit himself to the very initial steps, which in the case of humans correspond to the first 1,5-2 years of age (e.g. [7]).

## 2. Introduction

At the first let us see some terminology problems. “Artificial Intelligence” (AI) mentions the set of disciplines that partially represent intellectual behaviour: pattern recognition, natural language processing, etc. “Artificial General Intelligence” (AGI) - mentions the intellect that is equal to human beings have or exceeded it. There are no now special terms for the intellects of bacteria, plants, insects - individual and collective ones, - and for “consciousnesses” (or “awarenesses”) of mammals and birds, - also *individual* and *collective* ones. The author think that to reach the level of *human beings* in *consciousness* and *intellect* we should initially pass the level of high animals.

The author based his definition of *AGI-Individual Type* on *self-preservation instinct* [1]. The *self-preservation instinct* is the natural tendency to protect oneself from harm or death. It's a basic instinct in most organisms, and it is also known as the “survival instinct”.

The *species preservation instinct* was used by the author as the basis for the definition of *AGI-Collective Type* [1]. *Species preservation* is the practice of protecting species and their habitats to ensure their long-term survival collectively as the population. It involves understanding how species interact with each other and their environment, and how activities of members of the population impact them.

The main concept of AGI - as *Individual* as *Collective* types, - it is the concept of “border”. The *border* of living creature - it is *membrane* for bacteria and *skin* for animals and humans.

The “border” of populations of collective creatures - it is a set of characteristic *features* and *parameters* that give the possibilities to recognize the members of the *species* one belong to. This “border” is dependent from the way of communication and interaction.

The *border* of AGI-robot (hereafter “robot”) - artificial skin, - should give the possibility to recognize and locate the events of touching, tearing, penetrating through and preferably approaching. The establishing of the control of the *border* is the first learning procedure of the robot.

To have *subjective experience* one must at the first to know “where I am and where I am not”. That give the *predicate of existence*. To be aware of our existence or the “self” we should be aware of our *border*.

As the author discovered by the research of his children from birth to the first months of life the infant spends 2 first months to put under control his body in the sense of exploration his skin and all parts of his body [5, 6]. Initially, as the author revealed, the “self” is placed in one point between the eyes and from this point a child gradually learns about himself until he puts his big toe in his mouth and can't find anything

else further. This takes about 2 months of his life and from that moment on the child becomes an intellectual being because he now knows where he is and where he is definitely not. Of course this hypothesis should be proved by psychologists - the author's samples are only 3 experiments. But the author is not very obsessed by the exploration of *human being* nature, - the author is interested to design *artificial intellectual entities*. It is interesting that all books about infant psychology that the author read have no information about cognitive processes of infants in the first 2 month from the birth e.g. [7].

The both Agents: Agent 1 - “AGI-Individual Type” and Agent 2 - “AGI-Collective Type” are downloaded in the memory of the same AGI-robot - for Agent 2 simply there is no other place to be downloaded.

*AGI-Consciousness* supervises the procedure to establish the control of the *border* of robot. In some laboratories there were realized some projects to do it with *artificial skin* or *manipulators*. According to the author's model of AGI - Cognitive architecture AGICA [5, 6], - *AGI-Consciousness* will control the *border* for touching, tearing, penetrating through (and maybe approaching) and the integrity of functions of *Agent 1* and *Agent 2*.

The author cannot claim the AGICA will resolve “Hard Problem of Consciousness” - the question of how physical processes in the brain create the subjective experience of the mind. But the author can confidently state that in AGICA the robot will know in sure what is “his own experience” and what are the “external events”.

With Cognitive Architecture AGICA the author wants to have universal AGI-OS - means the operating system for AGI-robots [4]. Like *human beings* have the same brains with the possibility to learn and train it for any human tasks and activities we can try to design AGI-OS with the same property. The author is going to use for this purpose cognitive architecture AGICA.

It is clearly understood that currently used *operating systems* for computers should be used in the development of AGI only for modelling purposes. It would be very dangerous if computers' OSes migrate to AGI-robots. The author wrote about this problem and there is correspondent reference below [4].

The description of Cognitive Architecture AGICA can be found in [5, 6].

In the article we will use *transport robots* as the case for the integrity of presentation. It will be also assumed that these robots can have manipulators with the usual set of *sensors* and *motors*.

## 3. Problems

Let us list the problem questions that should be accounted in the design of AGI-OS and AGI robots.

Problems of learning

(1) Should we train robots “for living” or for “the task fulfillment”?

We understand that any “universal education” will generate many “useless knowledge” and it is more expensive. “Specialized education” is more rigid and less adaptive.

(2) How long we are going to train the robots?

Possible answers: a) 20-30 years like our children; b) 1-2 years; c) months; a) days.

The author think that we have to be industrially oriented, - an economic reality requires “days” for basic training. Other knowledge robots should acquire in the operations. To decrease the training in mass production we can use “pilot robots” to be preliminary trained for some tasks and later its “knowledge” will be simply downloaded in serial robots in serial manufacturing.

Of course, there may be the special cases, for example, “Robot for deep space missions”, - such case maybe will need years for training.

(3) Should robots inherit knowledge from their predecessors, and what kind? Will we use “natural selection” to select specimens for further breeding to use their knowledge as inherited knowledge of further generations?

Taking into account economical way of thinking the answer should be “yes”.

Ethical problem

(4) Do we ready to see among us intellectual entities with survival instinct and with instinct for the preservation of the species?

It is clear that AGI-robots with cognitive architecture AGICA will compete.

It is also should be clarified what AGI-robot should do when somebody is going to destroy it or make any harm?

The author think that such robots must not be among people - they have to live or in other planets or in some controlled areas and develop their own social population. It is possible to make the decision that such kind of robots we should make only to habitat the colonies in other planets.

Security Problem

(5) Are we planning to allow “self-reproduction” for robots?

By the way “Asilomar AI Principles” allow it... We can see there the item 22: “Recursive Self-Improvement: AI systems designed to recursively self-improve or self-replicate in a manner that could lead to rapidly increasing quality or quantity must be subject to strict safety and control measures”. The author think that “self-replication” should not be allowed at least on the Earth, but as an engineer the author prefers freedom in research and development.

Problem of psychological diversity

(6) Should we develop AGI-robots with the same structure, internal innate parameters and properties, or we have to initiate some initial diversity?

As we know, *human beings* are men and women with different psychology properties. There are also different psychology types (according to Carl Jung): “Extroversion” and “Introversion”, “Feeling” and “Thinking”, “Intuition” and

“Sensing”, “Perceiving” and “Judging”. We do not need strictly follow peoples’ type. But we should think if we need some initial diversity in AGI-Robots populations to develop their Collective Intelligence. This problem is not the first one in priority but not the least in the perspective.

We will mention below some current problems of AGI development that widely recognized.

(7) Common sense reasoning.

Reasoning from a *common sense* perspective still remains a problem for AGI development in current state, even at the level of a 5-6 year old child. The concept of *common sense* is very related to concepts of *self-preservation instinct* (survival instinct) and *species preservation instinct* that are the basis of cognitive architecture AGICA.

(8) High costs of learning of ANN.

The issue is to find the approaches a) to learn “from the first representation”; b) to use *unsupervised learning*.

(9) Unstable pattern recognition in ANN.

Currently small differences in input data/images can cause the errors in pattern recognition.

We will complete the problems item with the question that directly tied with the theme we are discussing here.

(10) Is language necessary for thinking?

There were many discussions on possible answers to this question in the past and they are still active. There is the hypothesis of *Mentalese* - “the language of thought; thoughts represented in the mind without words, especially complex thoughts built from simpler ones”. The author is sure on the basis of many scientific results in several disciplines, that the language - as the “the principal method of human communication, consisting of words used in a structured and conventional way and conveyed by speech, writing, or gesture”, - it is not the obligatory means for rational thought. As *rational thought* the author means in the meaning of “common sense”. *Common sense* causes *rational behavior*. Complex *rational behavior* demonstrates animals, birds, fish - as in *individual* sense as in *collective* one (“swarm intelligence”). *Rational behavior* in collective sense demonstrates insects with “swarm intelligence” but the collective intelligence will be beyond the scope of this article.

Of course, the *natural languages* is needed for communications, for coding of the data, for theories development but, as the author is sure, the level of cognition that we call “common sense” we can reach in AGI in some range without *language*. This is the issue is being discussing here.

The researchers of cognitive development of infants argue that in early development the following “image-schemas” are present in infants [7]: Path, Containment, Support, Link, Up-Down, Above-Below, Animate Motion, Inanimate Motion, Self-Motion, Caused Motion, Cause-To-Move-Inanimate, Source-Path-Goal, and Agency.

The resume of discussion of “problems”.

The answers to the questions and solutions for the problems mentioned above will impact the development of AGI. These solutions should be based critically on the *Space of Reasoning*.



This is the theme we are discussing here. *Space of Reasoning* will limit and shape any reasoning procedures and facilities we are going to use in AGI development - *symbolic* or *sub-symbolic* ones. This article concerns the *initial set of concepts* to support *reasoning* - the *a priori* concepts of *individual common sense*.

## 4. Current State

*Common sense* of humans is formed in infant period.

Infants. Mandler in [7, 9], considers how *meaningful representations* are formed in the first place. Models of *language acquisition* must include a plausible theory of how children create *meaning* and form *concepts*. The second is how children use these *representations* to facilitate *language learning*. According to Mandler, “Infants don’t wait for language to begin to think”; instead, long before any *language* appears, infants are building the representational base onto which they can map *language*. Mandler’s theory of “Perceptual Meaning Analysis” and its resulting “Image Schemas” respond to both of these requirements and offer a masterful account of *concept formation* and, ultimately, the origins of *language acquisition*. This is the most controversial aspect of Mandler’s theory. She proposes that *image schemas* are schematic, analog representations that summarize *spatial relations* and *movements* in *space*. *Image schemas* are not “images”, *per se*, as they eliminate figural detail and the complexities of movement. Instead, they are re-described fragments of perceptual information that represent an observed *event* in its most abstract, elemental form. Mandler proposes that the following *image-schemas* are present early in development: PATH, START PATH, END PATH, PATH TO, CONTAINER, SUPPORT, LINK, UP-DOWN, ABOVE-BELOW, INTO, OUT OF, THING, CONTACT, MOTION, ANIMATE MOTION, IN-ANIMATE MOTION, SELF-MOTION, CAUSED MOTION, BLOCKED MOTION, MOVE INTO SIGHT, MOVE OUT OF SIGHT, CAUSE-TO-MOVE-INANIMATE, SOURCE-PATH-GOAL, BEHIND, LOCATION, and AGENCY.

As Mandler claims there are no language researchers today who believe that one can learn language without some *conceptual system* upon which learning one’s native tongue can be based [10].

*Nondescriptionist theory* was expressed by Millican in [11]. It concerns the nature of *concepts* of what she called “substances” (following Aristotle’s “Categories”). The *category* of *substances* includes: (1) things we would ordinarily call “substances,” (namely, stuffs such as gold, milk, and mud), (2) things designated “primary substances” by Aristotle, namely, individuals (such as Bill Clinton, Mama, and the Empire State Building, along with) (3) things designated “secondary substances” (by Aristotle, namely, *real* (as opposed to nominal) kinds), as mentioned all - *substance concepts*. Millican claimed that these apparently quite different types of *concepts* have an identical *root structure*, and that this is possible be-

cause the various kinds of “substances” have an identical ontological structure when considered at a suitably abstract level.

Some researchers assume that infants are born equipped with *physical reasoning system* (PR) [12]. In this case it is considered that the PR-system operates without *consciousness awareness* - it is part of *unconsciousness*.

*PR-system* - structural information:

- (1) *Spatio-temporal information*;
- (2) *Categorical information*.

*Spatio-temporal information* describes how the *objects* are arranged and how this arrangements change over time.

*Categorical information* specifies what kinds of *objects* are involved in the *event* by providing *categorical descriptors* for each *object*.

Early *descriptors* include:

- (1) abstract ontological descriptors:
  - a) human - non-human;
  - b) agentive - non-agentive;
  - c) inert - self-propelled.
- (2) primitive functional descriptors:
  - a) open or closed at the top (to make containers);
  - b) open at the bottom (to make cover);
  - c) open from two sides (to make tubes).

As the core *concepts* Baillargeon and Carey [12] see:

- (1) “Force”;
- (2) “Internal energy”;
- (3) “Persistence”;
- (4) “Inertia”;
- (5) “Gravity”.

*Core Knowledge*. According to a prominent hypothesis [13] human cognition is composed of a set of *core systems* for representing significant aspects of the environment — namely, *objects*, *persons*, *spatial relationships*, and *number*. The hypothesis maintains that *core knowledge systems* are shared by other animals and are in place at birth.

Young infants have two *core knowledge systems* that provide the basis for representing *objects* (including *persons* and *places*) and the *concept* of *number* (“numerosity”) [14].

*Commonsense*. The “Common-Sense World”: the *common-sense world* is the world of what appears to us in everyday *perceptual experience*. It is the world as it appears to us directly – free of deliberations which would dig beneath the surface of appearances. It is a world in which people work, converse, judge, evaluate; a world of people, animals, tables, clothes, food, of red and green, hot and cold [15].

The *common knowledge* about the world that is possessed by every schoolchild and the methods for making obvious inferences from this knowledge are called “common sense”.

*Commonsense knowledge* and *commonsense reasoning* are involved in most types of intelligent activities, such as using natural language, planning, learning, high-level vision, and expert-level reasoning. How to endow a computer program with *common sense* has been recognized as one of the central problems of *artificial intelligence* since the inception of the

field [16]. *Common sense* is a big problem for artificial intelligence, and despite the attempts of many scientists this problem is still obscure (e.g. [17, 18]).

The spectrum of areas of concern of these works was broad: naive physics, time, plans, the minds of agents, even society and ethics. The outputs of these efforts were generally foundational axioms and rules; additional consequences of the specified axioms were logically entailed [19].

Some modern view of common sense in AI can be seen in [20-23].

In [19] we can see the definition: “Common sense is the ability to make effective use of ordinary, everyday, experiential knowledge in achieving ordinary, practical goals.”

In 2018 DARPA solicited innovative research proposals in the area of *machine common sense* to enable Artificial Intelligence (AI) applications to understand new situations, monitor the reasonableness of their actions, communicate more effectively with people, and transfer learning to new domains [24, 25].

It was declared that proposed research should investigate innovative approaches that enable revolutionary advances in science, devices, or systems. It was also declared that “specifically excluded is research that primarily results in evolutionary improvements to the existing state of practice.” The latter indicates that specialists from DARPA are sure that before the announcement there was not much...

What we can find about *common sense* in [26]:

1. *Commonsense knowledge* is common. *Commonsense* is in general concerned with generalities rather than with individuals.
2. *Common sense* supports *reasoning*. *Commonsense reasoning* is integrated with other cognitive abilities such as language use, vision, and manipulation.
3. *Common sense* extends across tasks and modalities. As a consequence, *common sense knowledge* is independent of any specific *task* or *modality*.
4. *Common sense* has a broad scope. It includes basic *knowledge* about *time*, *space*, *physical realities*, *biological realities*, *psychological realities*, and *social realities*. It also includes some degree of *meta-knowledge*.
5. Most *commonsense knowledge* is learned early in life.
6. *Commonsense knowledge* is language-independent.
7. *Commonsense knowledge* is the same for people of different cultures and of different historical periods.
8. *Common sense reasoning* is fast and intuitive; it falls within “System 1”. A well-known theory [27] in cognitive psychology posits that cognitive activities are divided into two systems. Processes in System 1 characteristically are executed quickly, do not require *conscious thought*, are not open to introspection, in at least in some cases are not controllable (one cannot decide not to interpret what one is seeing), and do not place a cognitive burden on working memory; vision is a paradigmatic example. Processes in System 2 are the reverse: slow, consciously carried out, consciously controllable,

introspectable, and taxing on working memory. System 2 processes can call on System 1 but not vice versa, since a fast process cannot use a slow subroutine. There is good reason to think that at least some System 1 processes can use commonsense knowledge; certainly unproblematic language interpretation; probably vision, particularly visions of scenes across time; possibly automatic manipulation. Given the above principle, that would mean that commonsense reasoning must be system 1, at least some of the time [26].

9. *Commonsense knowledge* can be expressed using simple language. However, there is a very large exception here, which is *commonsense spatial knowledge*.

There is widespread agreement that AI programs should not use full natural language text as a *knowledge representation language*. *Natural language* cannot be easily manipulated algorithmically. It is full of ambiguities. Its *meaning* is context-dependent. Its syntax is extremely complex, and strongly dependent on semantics. Its connectives (prepositions, articles, conjunctions) are remarkably vague and unsystematic. There are few powerful rules of inference on natural language strings. Moreover, natural language is notoriously ineffective at transmitting certain types of information, notably spatial information - “a picture is worth a thousand words” [18].

A systematic literature review to investigate the current state of *commonsense knowledge* exploitation in cognitive robotics is represented in [28].

The “grounded space of reasoning of common sense” is the subject of this article.

## 5. Space of Reasoning in AGICA

This is the main part of the article.

The subject of the article - “Space of Reasoning” - will be discussed 1) from the view of “common sense”; 2) from the view of “Individual Intelligence”.

“Collaborative robots” that should communicate with people intentionally, and the issue of “robot’s language emergence” in “AGI collective society” will be the themes of further discussions.

### 5.1. Prerequisites

The first two process of AGI-OS after downloading in robot hardware is 1) “*Border* exploration and put the border under control” and 2) “*Coordinate System* establishing”.

It is assumed that the CAD-model of the *border* is or in *embedded software* or in downloaded *software package*. The description of CAD-model has the appointing of *coordinate system*: the origin of coordinate system and axes directions. For example, in right-handed world coordinate system the origin is upper left corner of vision receptive chip of the *camera*: the x-axis points to the right, the y-axis points down along the *gravity force direction* (should be automatically controlled or output data should be recalculated correspond-

ingly if the angle between y-axis and *gravity force direction* occurred), and the z-axis points forward away from the camera. There can be other solution - e.g. the origin can be in camera focal point, - and there can be several *coordinate systems* (accelerometer, gyroscope, manipulator, the center of mass etc.).

Ideally if the *border* is represented with *artificial skin* that has embedded *sensors* of touching and tearing. In the world currently there are some successful projects of *artificial skin*. It still lack location facilities in *artificial skin* that human beings and animals have. But it is not the reason to wait. We can be sure that new versions of *artificial skin* will be developed. In the initial phases of AGI-OS development we can assume that the *border* will be represented by some proper arranged simple geometric figure: sphere, cylinder or rectangular parallelepiped. The last one is widely used now in autonomous vehicles to represent *objects* in the view. This geometric figure must be coordinated in the *coordinate system*.

The next possibility to use CAD-model connected to *coordinate system*.

If the robot has *manipulator* long enough with proper facilities to be located in the *space*, robot can touch itself and create in the memory surface of its body by coordinated triangles, as it used in computers' games for object modelling. The author read about such works done currently [8].

It is also possible to use stereo-vision if the robot will have such camera in the manipulator, - the 3D-model of body can be generated from stereo-vision data.

The instructions on *coordinate system* establishing can be embedded in AGI-robot hardware and AGI-OS can read and follow them after initialization. That is more universal approach. These instructions also can be the part of downloaded software package.

The results of the process "Border exploration and put the border under control" and "Coordinate System establishing" can be the any combination:

- a) sensing of the *border* by the a-skin ("artificial skin") *sensors* and established *coordinate system*;
- b) make the 3D-model of the body by touching with the manipulator or by stereo-vision;
- c) established 1) *coordinate system* (or the set of coordinate systems) and 2) the simple *geometric figure* to model robot *body* located in *coordinate system* that deliver the possibilities to calculate the referenced positions of the robot *body* and external objects.

When the *border* is specified in the *coordinate system* from this moment there be established: "internal space" of the *body* and "external space" of the *body*. Any *sensors' data* and *testing signals* from this moment can be identified as "internal" or "external" ones.

A model of robot *body* in some static position can be enlarged with the model of *space* that can be reached by *manipulators* - "manipulator's space". This *space* also will be coordinated. The *manipulator simulation procedures* can

generate the set of programs to reach by manipulator of any areas of this *space* with some rough accuracy. The programs can be addressed by associations with the *coordinates* of points should be reached.

Thus as the prerequisites we will have for granted the coordinated models of: *body*, *internal space*, *external space*, *manipulator's space* and the set of programs are ready for immediate use if it is needed to put the manipulator in proper place. Of course, these *programs* will give some rough positioning and they do not take into account possible *obstacles*. The accurate positioning will need accurate tuning with back loops.

## 5.2. Innate Concepts

The "innate concepts" could be combined in two groups: 1) the most general concepts, that can hardly be learned and trained - Specification 1 "Basic Innate Concepts"; and 2) the concepts and parameters belong directly to robot construction - the specifications of "construction innate concepts" (CIC).

The list of the specifications of "construction innate concepts" includes the following:

- a) Specification 2 "CIC: Internal Parts",
- b) Specification 3: "CIC: List of Signals",
- c) Specification 4: "CIC: Error Codes",
- d) Specification 5 "CIC: Scope of Functioning".
- e) Specification 6 "CIC: List of Goals".
- f) Specification 7 "CIC: List of Threats".
- g) Specification 8 "CIC: List of Needs".

There will be one more "innate concept specification" - Specification 9 "CIC: Spatial Concepts of Initialization Procedure".

In the Specification 1 "Basic Innate Concepts" we will have: "Space", "Close zone", "Far zone", "Scene", "Volume", "Object" ("Monolith Object", "Complex Object", "Container Object", "Hidden Object"), "Surface", "Solid", "Soft", "Time", "Causation", "Goal", "Threats", "Needs", "Understanding", "Context", "Movement", "Path", "Color".

"Space" - this concept as the other "basic concepts" will be preliminary defined in embedded software or downloaded with AGI-OS:

- (1) coordinate system;
- (2) *internal space* - full internal volume of the *body/object*: "body" - means "own body" and *object body* ("obstacle") in the view around,
- (3) *external space* - full *volume* of the external space (if there are no large obstacles around - as walls, etc. - the space will be unlimited, - till the horizon, as the opposite - the external space will be limited by such walls, rocks, etc.),
- (4) manipulator's space (see 5.1),
- (5) *occupied space*: "there is some *objects* there" (the predicates can be fuzzy ones),
- (6) *empty space*: "there is no *objects* there" (the predicate can be fuzzy one),

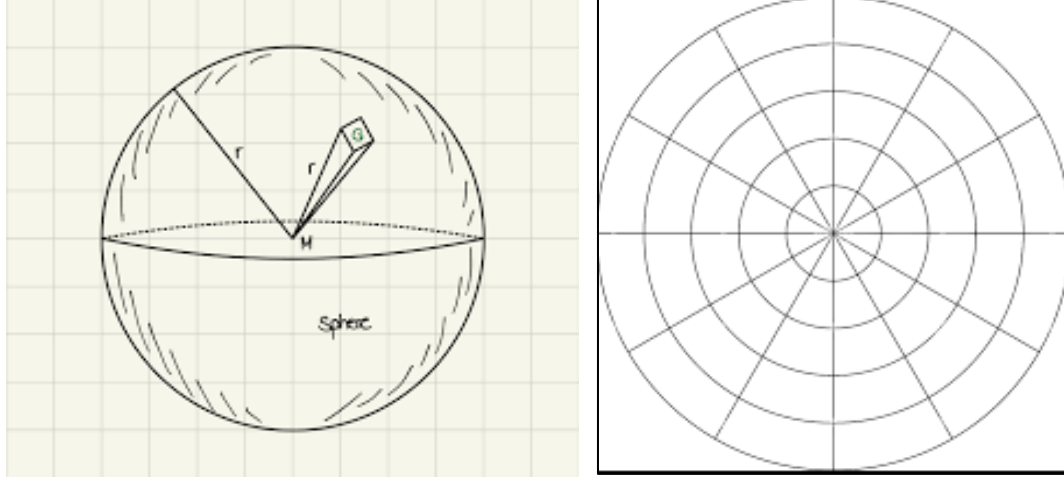
A *fuzzy predicate* is a predicate that is defined by a *fuzzy set* and provides a degree of satisfaction.

The *space* will be dynamically divided on 2 areas:

- (1) “close zone” - 3-dimensional, either some *sphere* (defined by the radius  $R$  in *polar coordinate system* with the center in the *origin* of coordinate system), (see [Figure 2](#)) or some *vertical cylinder* (“vertical” - along

gravity force direction, it is defined by the radius  $R$  in *cartesian coordinate system*, the center is in the *origin* of coordinate system and height  $H$ ), (see [Figure 3](#));

- (2) “far zone” - 2-dimensional, a zone that is outer of “close zone” - infinite one (limited by horizon in practical case - the length of the view).



**Figure 2.** Close zone as “sphere” and the cells as sectors (3D and projection).

The *far zone* will begin either from *sphere* or from the *cylinder* and this zone will be represented in 2D by applying to it some coordinated photos or images.

The *body* in this cases will be approximately in the center of the *zones*: *close* and *far ones*.

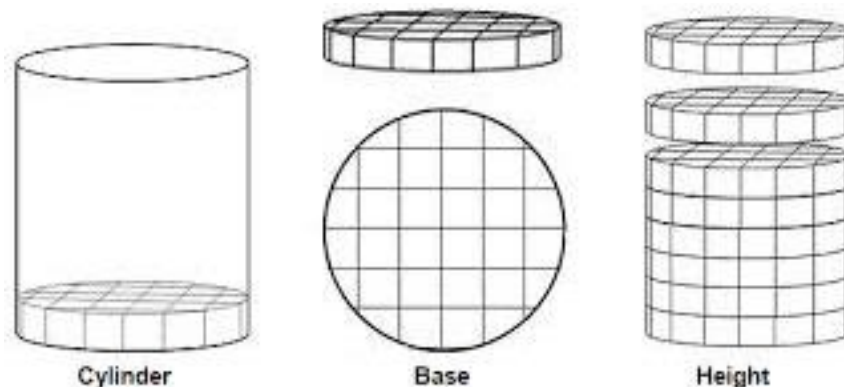
“Close zone”

The choice of *sphere* as the form of *close zone* can be made for UAVs or AUV/UUVs, for example, (UAV - “unmanned air vehicle”, AUV/UUV - “autonomous underwater vehicle”/“unmanned underwater vehicle”).

The choice of the *cylinder* as the form of *close zone* can be made for UGVs, ASVs (UGV - “unmanned ground vehicle”, ASV - “autonomous surface vehicle” (marine)).

*Close zone* in the *coordinate system* will be filled either with “cubes” (if *close zone* is defined as *cylinder*) or with 3D-sectors divided by a set of concentric spheres (see [Figure 2](#)) (if *close zone* is defined as *sphere*).

“Cubes” are defined by coordinates ranges and limited by the *cylinder* that defined *close zone* (see [Figure 3](#)).



**Figure 3.** Close zone as “cylinder” and the cells as cubes.

“3D-sectors” are defined by angles ranges and limited by the concentric spheres with the radiuses  $R_1, R_2, \dots, R$ , where

$R_{i-1} < R_i$ ,  $R$  - radius of *close zone* (see [Figure 2](#)).

In the *space* a *scene* can be modeled.



A *scene* can be two types: “real” or “imagined”.

Discrete Space with close zone of “cylinder” type

*Space* as modelling environment will have the metric parameters - “accuracy parameters”:

- a) minimum modelling length (minML);
- b) maximum modelling length (maxML=R).

*Filling cubes* for *close zone* can be in dimensions from (minML\*minML\*minML) till (maxML\*maxML\*maxML).

*Space* with *close zone* of “sphere” type

The same way for *close zone* that is defined as *sphere* the space will have:

- a) minimum modelling angle;
- b) minimum length;
- c) maximum modelling angle ( $2\pi$ );
- d) maximum length (R).

Any filling 3D-sector will have *basic angle* in this range and the length in the range (0, R).

“Cylinder-” or “spherical-” representations can have some advantages 1) in different tasks and area of application: air, land, water, underwater, - and 2) in dependence from the *sensors* used.

In such way *close zone* is represented with a *discrete space*. All *cells* of this *discrete space* can be numbered and uniquely represented by the *coordinates* of one point for any kind of cells: *cubes* or *sectors*. To update the *close zone* when the *body* moves, it will be enough to fill only the “new cells” (“incoming”) with parameters - like *delta-modulation* approach in communication.

Every *cell* in *close zone* will have the set of parameters (“density”, “color”, “sound”, etc.) for some modeled *scene* - “real” or “imagined” one.

Any *scene* (*real* or *imagined*) can have several *models* with different *accuracy parameters*: from rough to detailed representation.

“Far zone”

*Far zone* can be represented as either *surface of sphere* or *surface of vertical cylinder*. For *far zone* there are no need to model volumes in 3D. It will be enough to mark *far zone* with 2D-images that were coordinated on the surface. There are no need also to make some special projections to the curve surfaces of *cylinder* or *sphere* from the flat photos - flat photos should be only coordinated on the surface. With such approach “far zone” can be represented as some place of orientation marks.

The images in far zone can be represented with different accuracy (according to accuracy metric parameter - pixel dimension.)

In our common life we have very small perception of volumes on large distances. Our stereo vision gives to us the possibility to perceive the volumes only till 6 meters effectively and in more distances the effect diminishes. Further 200 m possibility to estimate volumes by stereo vision vanishes.

“Volume”

*Volume* can be of: *body*, *object*, finite part of the *space* defined by coordinates of ultimate points.

*Volume* is one of the properties of: *body*, *object*, finite part of the *space*.

*Volume* of an object can be represented as the geometric model in discrete space (by the composition of cubes (in cartesian coordinate system) or as the composition of 3D-sectors in polar coordinate system).

“Object”

Definition of *object*:

An object is a discrete, three-dimensional entity with:

- a) *Spatial Boundaries*: Occupies a finite *volume* in *space*, defined by *surfaces* or boundaries that separate it from its environment.
- b) *Material Composition*: Consists of detectable *matter* (e.g., metals, polymers, biological tissue) with measurable *properties* (density, conductivity, reflectance).
- c) *Functional Attributes*: Exhibits *behaviors* or *roles* (e.g., motion, rigidity, thermal emission) that distinguish it from its surroundings.

The concepts “environment”, “surroundings” we will see in our case as the synonyms of *space*.

The *properties* of *object* will include (but not limited by): matter (“solid”, “soft”, “liquid”, “gas”, “flame”), volume, color (RGB), density, conductivity, reflectance, motion, rigidity, thermal emission, etc.

*Object* can be represented by the geometric composition of *cubes* (or 3D-sectors) in *discrete space*.

A *matter* in our case - *concepts* for “common sense” *reasoning* - it is the substance that fills the *volume* of *objects* and is under/behind surfaces. A *matter* can be characterized as: “solid”, “soft”, “liquid”, “gas”, “flame”.

*Object* can be:

- a) “monolith object” - integral object;
- b) “complex object” - object can be divided to parts;
- c) “container object” - it is the *object* that has into its *body* some other *object* or *objects*;
- d) “hidden object” - if a robot sees some *object* in front of it, the robot should take into account that “behind the object could be some other objects and they can appear from there at any moment”.

For example, *container object* can be the car with driver and passengers - at any moment this *object* can stop moving and there will go some other *objects* from it.

In the modelling procedure any *object* initially should be seen as *container object* because of this is more general concept.

An *object* can be modeled either in the *discrete space* (in some *scene*) or alone.

If a *object* will be analysed alone - it will be modeled in its *own space* in some *coordinate system* that can be connected with some geometrical features of a object or not. The principles of modelling will be the same as it was described before.

“Surface”

Definition of a *surface*:

A surface is a continuous two-dimensional boundary of a

three-dimensional object or medium, characterized by:

- 1) Geometric Properties: shape, curvature, roughness, and spatial coordinates.
- 2) Material Properties: reflectance, conductivity, thermal emission, density, or acoustic impedance, which create detectable discontinuities at the interface.
- 3) Technical Identification. Surfaces are identified through interactions with energy or matter, measured by sensors that detect:
  - a) Electromagnetic Waves: Optical scanners (LiDAR, cameras) measure light reflection/absorption.
  - b) Mechanical Contact: Tactile probes or profilometers assess texture and topography.
  - c) Acoustic Waves: Ultrasonic sensors detect impedance changes.
  - d) Thermal Gradients: Infrared cameras map temperature variations.
  - e) Chemical Interactions: Spectrometers analyze surface composition.

This definition bridges abstract mathematical concepts (2D manifolds) with practical, sensor-based detection, ensuring surfaces are identifiable across technical domains.

For example, in the functional scope of transport robots of UGV-type (“unmanned ground vehicle”) initially the robot will make the hypothesis that it placed on the surface of terrain. For ASV-type (marine “autonomous surface vehicle”) the robot will make the hypothesis that it placed on the surface of water. After examination of the situation the hypothesis can be proved or rejected.

Land surface (terrain), water surface or a floor will be modeled by triangulation technique as it uses in computer games.

“Time dimensions” [3]

“AGI-Time” concept is related to:

- a) “AGI-Robot” – “own time”;
- b) “Object/Subject/Process” in the view of a robot (the “view” – maximum working distance for all sensors), or related to a robot, or for “imagined” Object/Subject/Process.

A robot can assign *time* to any viewed or imagined *Object/Subject/Process*.

*Object* and *Process* can be whether *external* or *internal* for a robot.

*Time* can be in the “states”: past; present; future.

*Time interval* or *time duration* is ( $T_2 - T_1$ ) - the result must be positive. If Time Dimension is “Cycle” (see below) and hour/minute/second are used the subtraction will be taken appropriately (mod60): e.g. (5 sec – 56 sec) = 9 sec.

*Duration* of “present time” (positive value) can be set and dynamically reset in dependence with the task and the environment.

*Time* as assigned to *Object/Subject/Process* can be of the types: indefinite, perfect, continuous.

*Time* can be marked with the properties as: “current”, “imagined”, “forecasted”, discrete (“calculated by “time discrete (TD)””).

crete (TD)””).

*Time* can be assigned to the *objects*. At any moment *object's time* can be in several of *time states*, in several *time types* and *marked* with the properties. For example, <time: future, continuous> can be also: <forecasted> and <imagined> at the same time. At any moment there can be several <time: past> or <time: present>.

*Time* is the complex of the following processes and data – named “*time dimensions*”:

- a) “*Chronological Time*” – corresponds to the “watch/timer time” – infinite number of time in some “time discrete” (TD): second or decimals of seconds; it is increasing permanently; it can be measured by “internal timer” or it can be requested/viewed from external watch; it will represent “Time Index” (for File Systems and Data Bases).
- b) *The set of “Cycles”* – some of them: year, day, - but there can be other ones; the “Cycle” is represented by: “Period” in TD; and “Phase” – the Time Index for the “start of cycle”; it is increasing permanently by TDs from “0” - the start of period, till “Period” - the end of the Cycle; “Period” and “Phase” can be corrected by a robot; the Cycle (any existing one) can represent “Cycle Index” (in TD sums).
- c) *The set of “characteristic moments”* – can be assigned to *Object/Subject/Process*; can be or “Time Index” or/and “Cycle Index” (Cycle Indexes), - for any *Object/Subject/Process* can be assigned any sets of *characteristic moments* (ordered set).
- d) *The set of “characteristic events/states”* – can be assigned to *Object/Subject/Process*; the valid set of *characteristic events/states* must correspond to causality.

Any *time dimensions* can be associated with the parameters or descriptions.

For any *time dimension* there can be assigned several time discrete (TD<sub>i</sub>) and any process can be represented in several TD<sub>i</sub>.

“Scene”

*Scene* - *external space* populated with *objects* and *surfaces* for some moment of *time* (there can be assigned several *dimensions of time*)

*Scene* can be “real” (as the model of *real world*) and “imagined” (as the “imagined model”). *Imagined scene* can be occupied by “imagined” *objects* and *surfaces*, and by “real” *objects* and *surfaces*. *Imagined scene* will have the attribute “imagined” *time dimensions*.

AI-Understanding [3]

This concept concerns:

- a) States of AGI-robot “KNOW” and “DO\_NOT\_KNOW”;
- b) transitions from KNOW to DO\_NOT\_KNOW, and from DO NOT KNOW to “KNOW”;
- c) the decisions making: «Understood» and «Did not understand».

To simplify the issue, the definition will concern ONLY

interactions & operations in “real world” environment, - we will postpone for other articles the issues of “imagined world” environment.

The state of AGI-robot KNOW is:

- a) the starting state of Agent 1 (“AGI-Individual Intelligence”) – from the moment of the first “turning on” of the system (from «the birth»);
  - b) preferential state of automate, – it is provided by design.
- State KNOW is the function of:
- a) sensors’ signals;
  - b) context (current one recognized / classified).

The current <Context\_x> is some “context” selected through the *reasoning procedure* from the “List of contexts” in the memory of AGI-Robot. The *List of contexts* can be initially downloaded or trained / self-trained by AGI-Robot before.

The state KNOW will be kept till the decision “Did not understand” will be made.

The decision “Did not understand” initiates the state DO\_NOT\_KNOW (transition from KNOW to DO\_NOT\_KNOW).

The decision “Did not understand” can be made on the base of <Context\_x> – currently identified *context*, - by (any combination of):

- a) the forecast did not match the current situation,
- b) the results of activities were not reached,
- c) knowledge base has no correspondence,
- d) pattern recognition/classifying – failed,
- e) sensors’ data analysis – there is no waited result,
- f) logic reasoning – there is no waited result.

In the state DO\_NOT\_KNOW robot stops all active actions in the environment, of course, if the actions can be stopped (if not - the robot assures only support for stability of actions without changings).

In the state DO\_NOT\_KNOW robot can be only for limited time  $T_i$ ,  $i$  – number of the <Context  $i$ > - every *context* has the correspondent  $T_i$ .

During time  $T_i$  a robot can: (1) make the decision “Understood” and return to the state KNOW (transition from state DO\_NOT\_KNOW to the state KNOW). If the robot can test the decision “Understood” as the hypothesis for the time  $T_i$ , the robot should do it. If during time  $T_i$  the decision “Understood” could not be made, (2) the situation (the cause of the decision “Did not understand”) will be stored in the memory with the character: <Did not understand> and robot will be returned to the state KNOW.

“Context”

For example, for *autonomous cars* the List of contexts can be the combinations of the following terms:

- a) city,
- b) rural area,
- c) good weather,
- d) bad weather or environment conditions: rain (with the rate assigned: 1,2,3...), fog (with the rate assigned: 1,2,3...), snow (with the rate assigned: 1,2,3...), ice,

wind (more than some threshold value with the rate assigned: 1,2,3...), earthquake (with the rate assigned: 1,2,3...),

- e) driving,
- f) stop,
- g) highroad,
- h) residential development zone,
- i) gas station,
- j) service station.

Different *contexts* require to meet different rules and follow them.

“Solid”

Can be trained or self-defined with accelerometers.

*Surface* or *object* can be solid.

“Soft”

Can be trained or self-defined with accelerometers.

*Surface* or *object* can be soft.

“Causation”

Definition of *Causation*:

“Causation refers to the relationship between *causes* and *effects*, where one *event* (the *cause*) is responsible for bringing about another *event* (the *effect*). In simpler terms, *causation* implies that a change in one variable (the *cause*) produces a change in another variable (the *effect*).”

In the phase of “common sense” development we will see as the *cause* only:

- a) *space conditions* (for land - terrain conditions - e.g. “pit”, for water - e.g. “wave”, for air - e.g. “whirlwind”),
  - b) *objects* (as the obstacles, “solid” ones in more cases);
  - c) *objects* in contact - the cause of interaction;
  - d) internal conditions (errors, malfunction).
- “Goal”

The Specification 6 “CIC: List of Goals” will have preliminary defined *goals* and the ways to reach them (in the terms of specifications mentioned above).

In the “List of Goals” the Goal 1 is “Keep the existence and integrity”.

The limitations of the activities of robot in pursuit of a *goal* will depend from the *context*. If a robot operate in other planet without contact with people the limitations will concern only the activities in the zone close to the spaceship or some installed equipment. If people are close there will be assigned also some safety rules.

“Threats”

There should be Specification 7 “CIC: List of Threats” in correspondence with contexts, space, objects nearby, goals.

“Needs”

There should be Specification 8 “CIC: List of Needs” in correspondence with contexts, space, objects nearby, goals, and the activities to satisfy them.

The Need 1 in the *List of Needs* will be “Energy supply”.

“Movement”

Definition:

*Movement* in a technical context is the measurable change in *position* or *orientation* of an *object*, which can be identified

and analyzed using specialized tools and methods.

The movement can be ongoing and completed  
“Path”

Definition:

Path in a technical context is the measurable change in position of an object that moved before, which can be identified and analyzed using specialized tools and methods.

“Color”

As the “color” we will use *RGB color coding system* for optic diapason.

In the cases of Infrared-, Ultraviolet-, RF-, and other frequency ranges should be used correspondent industry standards.

Remark: the proposed content of Specification 1 “Basic Innate Concepts”, of course, is very general and any specific application could require to enlarge this list.

### 5.3. Initialization Procedure - Specification 9 “CIC: Spatial Concepts of Initialization Procedure”

As it was represented by the author in [5, 6] the first concepts that will be generated by AGI-robot with cognitive architecture AGICA by *self-learning procedure* after *Body exploration* and *coordinate system* establishing are the following Spatial Concepts:

- a) “My Body” (the *space* into the “border” - “Internal Space”, “Volume” (as geometrical model)),
- b) “Position”,
- c) “Left”,
- d) “Right”,
- e) “Up”,
- f) “Down”,
- g) “Above”
- h) “Below”
- i) “Forward”,
- j) “Backward”,
- k) “Around”,
- l) “Touch”,
- m) “Nearby”,
- n) “Far”,
- o) “Close”,
- p) “Into”,
- q) “Outside”.

This concepts are listed in the Specification 9 “CIC: Spatial Concepts of Initialization Procedure”. This specification with the correspondent descriptions of the concepts will be downloaded in the initialization procedure or will be the part of *embedded software* of a robot.

The descriptions of these concepts will include the rules of identification of the cases. For example, the description of “Left” could look like: “In the direction of X (axe X)”, the description of “Up” - “In the direction of “minus Y” (the opposite direction of axe Y), the description of “Far” can be: “The space in *far zone*”, etc.

The concept “Position” can be described:

- a) in *close zone* - the set of cells in *discrete space* that have characteristic *properties*;
- b) in *far zone* - the *sector* from *origin of coordinate system* perspective (“observer view”) that have characteristic *properties* (illumination, color).

### 5.4. Options in Innate Concepts List

It looks like reasonable approach to enlarge rationally the list of “innate concepts” in Specification 1 “Basic Innate Concepts” *a-priori* with as many concepts as we can. This way we save resources for training. Of course, there should be correspondence between the possibilities for the robot to identify/recognize the *concepts* by available *sensors*.

As some additional *innate concepts* we can see the following:

primitive geometric forms: sphere, ellipsoid, cube, parallelepiped, pyramid.

### 5.5. Specifications of “Construction Innate Concepts” - CIC

CIC-specifications are (CIC - “construction innate concepts”):

- a) Specification 2 “CIC: Internal Parts”,
- b) Specification 3: “CIC: List of Signals”,
- c) Specification 4: “CIC: Error Codes”,
- d) Specification 5 “CIC: Scope of Functioning”.
- e) Specification 6 “CIC: List of Goals”.
- f) Specification 7 “CIC: List of Threats”.
- g) Specification 8 “CIC: List of Needs”.

The last 3 specifications were described above.

In Specification 2 “CIC: Internal Parts” (in *embedded software* or downloaded in *initialization procedure*) has the descriptions for the *concepts* of *internal parts* of the robot: “wheel 1”, ..., “wheel 4”, “motor”, “manipulator”, “camera”, “LIDAR”, microphones, accelerometers, etc. These *concepts* can be specified with *CAD-models* in *coordinate system* - the *part* alone and represented in *assembly drawing*.

There also should be the specifications of the signals - Specification 3: “CIC: List of Signals”- for the parts that are electronic or electronically controlled devices: inputs and outputs.

“Input” signals can be: signals from the sensors, control signals, power supply.

“Output” signals can be *testing signals* about the internal state of the devices, or any kind of the signals for other devices (for functional units, for illumination and displays).

The specification of the signals will be the source for *testing procedures*.

The errors and mistakes can be modeled as “pains” in analogy with living creatures, - if something is wrong with the hardware or there are some errors in functioning.

To model “pain” it is not very complex task, - the robot can



localize this “pain” by “Signal List”, “Wiring Diagram” and CAD-models, and can assign some “rate” for this “error code” according to the preliminary prepared specification in the *embedded software* - Specification 4: “CIC: Error Codes”, - or make this by the estimating of the consequences of the errors, that means the robot can analyse the harm for functionality. The “rate” of the “pain” will influence the decisions the robot makes for further activities and readiness for operations.

The next specification - Specification 5 “CIC: Scope of Functioning”. There will be the list of activities that robot can do with the parameters descriptions: movements, maneuvers, manipulations, interactions with the environment and analyzing of the environment. For any activities there will be the procedures to control them with the references to: internal parts that is involved in the procedure, the control signal diagrams, telemetry, testing procedures.

Every “activity” that is listed in Specification 5 “CIC: Scope of Functioning” will correspond to some “verb concept”. For example, if the robot can “move”, the description of the “movement” will have: the procedure to control the motor (with the parameters should be set to reach the needed output - e.g. “direction”, “speed of movement”, etc.) and the procedure to measure the “distance passed”.

All *concepts* concerning the robot construction (according to the CAD-drawings), activities, parameters of activities should be described in the correspondent specifications.

## 5.6. Space of Reasoning

*Space of Reasoning* in AGICA is represented by:

- a) *coordinate system* (there can be several ones for different tasks);
- b) *discrete space*: close zone (represented with accuracy metric parameter), far zone (represented with accuracy metric parameters);
- c) *scenes* - geometrical models with *close zone* (populated with 2D-surfaces in 3D-environment and with 3D-objects, *far zone* (populated with 2D-images (or 2D-objects if they was recognized or assigned)); *objects* and *surfaces* are marked with *properties* (terrain, colors, etc.);
- d) *innate concepts* (listed above and possibly enlarged with additional ones according to the tasks requirements);
- e) “acquired concepts” - the *concepts* acquired either in the procedure of *supervised learning* or by *self-training* or by *analysis* of data received during operations, and *reasoning*;
- f) non-conceptual external properties - they are represented by signals from the sensors,
- g) AGI-emotions, as the modes of AGI-Consciousness [2];
- h) *Attention* - the *attention* mechanism is implemented by selecting a compact subset of *cells* in the *scenes* in the *discrete space* in the *close* or *far zone*; *attention* can be paid to *objects* and *surfaces*; the *scenes* (objects, surfaces) can be *real* or *imagined*.

*Attention* can migrate not only from one area of *space* to another in the selected *scene* but in the same area of the scene from *one level of accuracy* to another one.

The list of *concepts* can be enlarged by *supervised learning* and *unsupervised one* (“self-training”, “learning in the operations”).

We want to draw special attention to the fact that any *scene* in the proposed approach can be represented with different *accuracy metric parameter* for reasoning. For example, there is the Scene 1 with the *accuracy metric parameter* (AMP) = 1 meter - Scene 11; and the same scene with AMP = 0,1 meter - Scene 12. Scene 12 has the model ten times more accurate than Scene 11. But Scene 12 will need much more processing resources. In some situations for transport robots it will be possible to use for route generation more rough model - Scene 11 - make some forecast of the route and then check it, for example, in some Scene 13 with AMP = 0,3 in some parts. If the results of analysis for the data with different accuracy will match the calculated route can be assigned as *active*.

When the *Attention* is appointed to some *object* to be analyzed the AMP can be selected 0,01 meter or less to have the possibility to process more precise view of the *object*.

In this approach the key assumption is that the analysis of the same *object* or *scene* with different *accuracy* must not contradict each other. If it is - the analysis should be repeated, - there is an error in the previous one. As the prediction we can use rough representation, and as the test - in some parts of the prediction - we can use more precise representation. Such approach will decrease the requirements for processing power.

## 6. Some Foreword on Reasoning

If we restrict the concept of “common sense” to *spatial relations*, *time*, and *interactions* with the *environment* (such as *terrain*, *objects*, etc.), while excluding social relations, we are focusing on the basic, intuitive understanding of the physical world that allows individuals (robots) to navigate and interact with their surroundings effectively. This type of *common sense* includes:

### (1) Spatial Relations perspective:

- a) Understanding the relative positions, distances, and orientations of *objects* in *space*.
- b) Recognizing that *objects* occupy physical space and cannot be in the same place simultaneously.
- c) Knowing how to navigate from one location to another, avoiding obstacles, and understanding basic directions (e.g., left, right, up, down).

### (2) Time perspective:

- a) Grasping the sequence of events (e.g., cause and effect, before and after).
- b) Understanding the concept of *duration* (e.g., how long something takes).
- c) Recognizing that time flows in one direction and that past events cannot be changed.

- (3) Interactions with the Environment perspective:
- a) Knowing how objects behave under physical laws (e.g., gravity causes objects to fall, water flows downhill).
  - b) Understanding basic cause-and-effect relationships in the physical world (e.g., pushing an object makes it move).
  - c) Recognizing the *properties* of materials (e.g., solid objects are hard, liquids flow, gases disperse).
- (4) Terrain and Objects perspective:
- a) Navigating different types of terrain (e.g., walking on flat ground vs. climbing a hill).
  - b) Interacting with *objects* in a way that aligns with their intended use (e.g., using a chair to sit, a door to enter or exit).
  - c) Avoiding hazards in the environment (e.g., recognizing that a cliff edge is dangerous).

This restricted form of *common sense* is fundamental to survival and functionality in the physical world. It is often *innate* or *learned* through early experiences and is shared across cultures, as it is based on universal physical laws and realities. However, it does not involve social or cultural norms, which are more abstract and context-dependent.

The author think that the “Space of Reasoning” of cognitive architecture AGICA proposed in this article in general met the terms listed above.

The list of *common sense innate rules* can be prolonged. For example, the following rule can be added: “*self-movable object* can change the *position* and went out of the view”. This rule also can be used as the *classification rule* for the concept “self-movable object”. But this article does not concern the approaches for reasoning and logic, - we are discussing here only “space” for that.

## 7. Some Foreword of Collective Common Sense

In cognitive architecture AGICA *AGI-Collective Type* can be established in the group of *AGI-robots* with *AGI-Individual Type*, and try to reach the following goals [1]: (1) to enlarge the population by all controlled means: reproduction, protection of members of the population from attacks on “existence” and “integrity”, increase “life cycle” expectancy and “living conditions” of members of the “population”, (2) to organize mutual activity of members (*AGI-robots*) to enlarge the “living resources for population”, (3) to fulfill other tasks together to reach mutual goals.

For the occurrence of the phenomenon of the *AGI Collective Type* must be simultaneous fulfillment of the following conditions:

- a) the group of *AGI-individual type robots* must exist,
- b) the presence of an inherited / learned *kinship characters* and the concept of or “one rank robots’ population” or “hierarchical structure of robots’ population” must exist,

- c) the presence of an inherited / learned concept of *group interest*,
- d) the presence of an inherited / learned “*process / plan*” to reach the objectives on 3),
- e) the presence of an inherited / learned «*incentive / penalty*» (may be several types) to enforce members of the group to follow the *Group Priorities* ».

“Collective Intelligence Concepts” (in general and in *common sense* perspective) - they are “goal-oriented concepts” that should serve the tasks listed above for *AGI-collective type*.

The author is sure that we will see a society and an ethics of AGI-robots soon. This society will be structured according to the types of robots - and every community of robots will have their own dialect if not language. As the author can imagine some “general robot language” emerges because we have unified types of computers, sensors, manipulators, accelerometers, etc. Thus robots will have many common features. But differences in type will initiate some *dialects* generation. All that concerns these issues will be the subject of further discussions.

## 8. Conclusion

The success of LLM-GANs create new possibilities to optimize the way of living of human popularity. But they need so much resources - processing, power, - that this technology could support robots only remotely through language based interaction. The development of Cognitive Architecture AGICA is focused in the case of AGI-robots that can operate independently. The author intention to design some universal operating system - AGI-OS - that can be used as the platform for AGI-robots for different applications. The computer operating system - MS Windows, LINUXes, MAC-OS - definitely do not meet the requirements of AGI development [4]. They simply were designed for other purposes.

The presented approach allows using both symbolic and network (subsymbolic) approaches for reasoning.

## Abbreviations

AI	Artificial Intelligence
AGI	Artificial General Intelligence
AGI-OS	Artificial General Intelligence Operating System
AGICA	Type of Cognitive Architecture
ANN	Artificial Neural Network
ASV	Autonomous Surface Vehicle (Marine)
AUV	Autonomous Underwater Vehicle
a-skin	Artificial Skin
CAD-model	Computer-Aided Design Model
CIC	Construction Innate Concepts
LLM-GAN	Large Language Model - Generative Adversarial Network
TD	Time Discrete
UAV	Unmanned Air Vehicle

UGV	Unmanned Ground Vehicle
UUV	Unmanned Underwater Vehicle
3D-model	Three-dimensional Model

## Author Contributions

Sergii Kornieiev is the sole author. The author read and approved the final manuscript.

## Conflicts of Interest

The author declares no conflicts of interest.

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