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Anticipations as Abductions in Human and Machine Cognition

Deep Learning: Locked and Unlocked Capacities

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Abstract: In my opinion, it is only in the framework of a research dealing with abductive cognition that we can analyze important cognitive aspects of human and machine capacities. From the point of view of human (and of some animal, mammals for example) capacities the phenomenological concept of anticipation (seen as a kind of abduction), which is related to the problem of the spontaneous generation of spatiality and its three-dimensionality, will be central. I will describe that anticipations can be seen as types of visual and manipulative abduction and also fruitful to illustrate, in the case of human and machine capacities, the respective role of two kinds of strategic reasoning: locked and unlocked abductive strategies, which characterize the basic cognitive pro- cedure of "reading ahead". The specificity of these contrasting inferential strategies is also related to their potentiality in producing different kinds of hypothetical outcomes, which in turn represent dissimilar levels of knowledge creativity. This diversity is also fundamental to depict the special character, the kind of creativity (often amazing), and the limits of current computational deep learning AI systems, such as AlphaGo, which realize abductive cognitive processes.

Keywords: *abduction; human and machine cognition; creativity; eco-cognitive openness; locked and unlocked capacities; locked and unlocked strategies; Go game; AlphaGo; deep learning.*

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1. Introduction

In my opinion, it is only in the framework of a research dealing with abductive cognition that we can analyze important cognitive aspects of human and machine capacities. To reach this target my Eco-Cognitive (EC-model) of abduction is of help, especially because of its clarification of the so-called fill-up and cutdown problems. From the point of view of hu- man (and of some animal, mammals for example) capacities the phenomenological concept of anticipation (seen as a kind of abduction), which is related to the problem of the spontaneous generation of spatiality and its three-dimensionality, will be central. Anticipations are related to the abductive function of what Husserlian phenomenology called *Abschattungen* (adumbrations), as they are described in the framework of the philosophical tradition of phenomenology. I will describe that anticipations can be seen as types of visual and manipulative abduction and also fruitful to illustrate, in the case of human and machine capacities, the respective role of two kinds of strategic reasoning: *locked* and *unlocked* abductive strategies, which characterize the basic cognitive procedure of "reading ahead". The specificity of these contrasting inferential strategies is also related to their potentiality in producing different kinds of hypothetical outcomes, which in turn represent dissimilar levels of knowledge creativity. This diversity is also fundamental to depict the special char- acter, the kind of creativity (often amazing), and the limits of current computational deep learning AI systems, such as AlphaGo, which realize abductive cognitive processes. I will try to clarify that these systems are seriously constrained in their cognitive capacities, be- cause they jeopardize what I called in my more recent studies on abduction "eco-cognitive openness", which instead splendidly governs human cognizers when they are executing deep kinds of abductive creative reasoning, in which the related capacities are unlocked.

2. Unlocked Cognitive Capacities Standardly Characterize Hu- man Knowledge-Enhancing Abduction

I think that the concept of abduction is very fruitful to provide new light on some basic prob- lems related to the inferences typical of human and machine capacities, at least when dealing with hypothetical reasoning, especially of creative kind. I have recently introduced, in the framework of my studies on abductive cognition (Magnani, 2015a) the concept of *knowledge- enhancing abduction*, that will be useful to explain the status of those types of cognitive strategies I am illustrating here, called *unlocked abductive*

strategies. Together with this concept, and the related ones of model-based and manipulative abduction, it will be the role of anticipations (in the perspective of the cognitive problem of the genesis of space thanks to the so-called *Abschattungen*—adumbrations), as described by the Husserlian phenomenological tradition, that will constitute the intellectual instrument able to further deepening the concept of strategy that plays a role in the so-called *locked abductive strategies*. These strategies characterize the kind of creativity (often amazing), but also the limits, of current computational AI systems, such as AlphaGo, which realize abductive cognitive processes. Indeed I will try to clarify that these systems are seriously constrained in their cognitive capacities, because they jeopardize what I called in my more recent studies on abduction "eco-cognitive openness", which instead splendidly governs human cognizers when they are executing deep kinds of abductive creative reasoning, in which the related capacities are instead *unlocked*.

2.1. Cutdown and Fill-Up Problems: Two Fundamental Aspects of Abduction in the Perspective of the Eco-Cognitive Model (EC-Model)

It is Woods (2011, p. 242) that underlined the importance in abductive cognition, of the so-called fill-up and cutdown problems. Many abductive problems contemplate many acceptable guessed hypotheses and we need to reduce them generating the best possible choice: it is the problem of *hypothesis selection*. Equally important is also the problem of *thinking up* the potential candidate hypotheses for selection. The classical logical studies on abduction classify consistency and minimality constraints as dominant especially in the so- called selective abduction—for example in diagnostic reasoning, in which abduction resorts to an inferential process of "selecting" from an encyclopedia of pre-stored hypotheses—and disregard the analysis of *creative* abduction (abduction that generates new hypotheses). I have introduced selective and creative abduction in (Magnani, 2001). The reader can find a summary regarding this dichotomy and other important taxonomies which illustrate various features of abduction in a recent book by Park (2015). Of course strategic reasoning and heuristics are occurring at the fill-up level: creative cognition is a typical example, and in this case, for example in scientific discovery, consistency and plausibility are not necessarily required: Paul Feyerabend famously noted in *Against Method* (1975), that contradiction can play a pivotal role in producing hypotheses.

Is abductive cognition ignorance preserving (or ignorance mitigating), as Gabbay and Woods (2005) contend when illustrating their GW-Schema? Being an *answer* to an ignorance-problem abduction does not

totally cancel the ignorance, because it is neither resolved nor left untouched. In this perspective ignorance is definitely eliminated only with the necessary help of an empirical evaluation, that Peirce represented as an inductive phase, in which hypotheses can be corroborated and/or eliminated.

However, I strongly contend that the assumed ignorance-preserving nature of abduction presents a serious limitation. Indeed we can easily detect, seeing at various concrete cases of abductive cognition, that

- the cognitive procedures of generation (fill-up) is sometimes completely adequate— even when the inductive evaluation level lacks—to *find* and at the same time adopt as appropriate or true an abductive hypothesis. In this case we gain cognitive outcomes that are characterized by a knowledge-enhancing power.

In sum the best selection—regularly on account of the use of strategic reasoning and fit- ting heuristics—is promptly realized in absence of the assistance of an experimental phase. Indeed at the center of my view of cognition there is a "pragmatic agent" acting "on the ground", that is, in the situation of actual life. I see reasoning as something executed by cognitive systems. A cognitive system can be seen, in general, as a triple (*A, T, R*), in which *A* is an *agent*, *T* is a *cognitive target* of the agent, and *R* indicates the *cognitive resources* that the agent can exploit when trying to reach the target result, that is information, time and computational capacity, are essential and the most important resources. Furthermore, my agents are also *embodied distributed cognitive systems*: cognition is embodied and the intertwining between brains, bodies, and external environment are its dominant features.

Seeing abduction as it is in general is occurring in human settings teaches us that the fill-up aspect is notably *contextual*: it is possible to abduce a model or an idea at the vari- ous phases of scientific inferences, in the dominant atmosphere of rationality, but it is also possible to abduce a hypothesis in literature concerning a character (Jean Valjean, for in- stance), or in moral reasoning (where the choice of a moral principles or judgment becomes the starting point of a possible moral action), but also in a combative board game such as Go (or in its computational counterpart AlphaGo) or Chess.

2.2. The Knowledge-Enhancing Character of Abduction

I have maintained that abduction can originate truth even in absence of an empirical evaluation: in this sense abduction is not always ignorance-

preserving (or ignorance mitigating). Peirce himself was crystal clear: he said that abduction "come to us as a flash. It is an act of insight" (Peirce 1931-1958, p. 5.181) and it is also endowed with a wonderful capacity to "guess right" (Peirce 1931-1958, p. 6.530). Hence abduction, preserves ignorance, in the sense I have described above, but also can rapidly generate truth because possesses the ability of guessing *right*.

In sum

- *I am contending that abduction—and so the possible inferential strategies that characterize it—can be knowledge-enhancing in absence of the empirical evaluation*.

Two final relevant important results concerning the status of the concept of *ignorance*

as it emerges in this conceptual situation have to be stressed:

1. abduction, also when considered as an inference to the best explanation in the "received" sense I have illustrated above, is always *ignorance-preserving*: indeed ab- duction is "always" and constitutively a kind of transitory cognition, and—ideally— you can retire abductive conclusions previously reached (even if empirically corroborated, that is when satisfactorily considered "best explanations"), in front of new information, evidence and data. We know that logic called inferences of this type nonmonotonic, and epistemology characterized modern science as a kind of cognition in which truths are never fixed and absolute: in this sense abduction correctly refers to the "spirit" of modern science;
2. the fact that ignorance is preserved, in the sense I have described in the previous item, which also refers to the cognitive structure of science, does not exclude that it is also knowledge-enhancing because new truths can be and "are" proposed which *are not inevitably best explanations intended as hypotheses which are empirically evaluated*, that is without reference to the role of evidential/empirical weight.

In the following sections I will describe forms of strategic cognition, in both human an machine situations, in which new knowledge is constructed (and consequent action triggered) even if the empirical evaluation is not present: cases of knowledge-enhancing ab- ductions.

3. Natural Games: Anticipations as Abductions in Human Cognition

3.1. Human Capacities in Natural Games

This subsection is devoted to the study—in terms of abduction and in the perspective of dis- tributed and embodied cognition—of the so-called "anticipations": they will be extremely useful in delineating the main properties of what I call "unlocked" capacities, with respect to the "locked" ones. In my research on abduction I have proposed the concept of manipulative abduction, which is important to the aim of deepening the cognitive and epistemological meaning of the concept of anticipation in human capacities: in manipulative abduction action can provide otherwise unobtainable data and the agent capable to solve puzzling problems exactly thanks the manipulation of the external world. I contend that manipulative abduction is occurring when we are thinking "through" doing (Magnani, 2009).

Games such as Go certainly involve abductive manipulative processes; inferences are indeed interlaced with the manipulations of the stones and several embodied features are in- volved, together with the active perception of the whole setting, the adversary, etc., and the cognitive process not only pertains sentential aspects but it is also executed in a distributed cognitive situation, in which models, props and artefacts, internal and external representations, sensations, and manipulations are of great importance.

Something similar is occurring in the phenomenological example illustrated in this section. We are dealing with a "natural" play in the intertwining between human capacities and the environment, where certain affordances are offered and subsequently reworked. Strategies at play are "unlocked": a comparison with the case of "artificial and computational games" will reveal they are characterized by "locked strategies" (see below subsection 3.2 and section 4.1).

How do humans construct "idealities", geometrical idealities, and the objective space? A philosophical answer is given by Husserl, who describes a cognitive process we can surely call abductive, which begins with the prepredicative world of primordial and immediately given experiences, totally overt and available, and in which human capacities are characterized by "unlocked" cognitive strategies. In subsection 2.1 above I quoted the role of perception and of kinesthetic processes in Peirce's thought and its abductive character: this is further emphasized when we deal with the Husserlian framework, especially if seen in the light of some neuroscientific data. It is thanks to kinesthetic capacities that a protogeometry can be built to reach "idealities": in such a way the

appearances of things provided by perception are no more immediately given but already considerably ordered and the way adopted to organize them is performed by sensible schemata that originate through a continuous change of the so-called *adumbrations* [*Abschattungen*], that refer to fragmentary features of objects. It is only thanks to the unification of these adumbrations that we can actually become certain they pertain to the same and single object (noema) (Overgaard & Grünbaum, 2007).

Visual, kinesthetic, and motor actions govern the formation of adumbrations and are obviously linked to several manipulations of various portions of the external world. Being fractions of the visual field, the adumbrative features of things need be managed by an activity of gluing different fillings-in of the visual field to form the time-related continuum of a perceptive result in a global space. Of course it is the human capacity to perform kinesthetic circumstances and successions that is at stake, relative to the movements of the perceiver's own body. Also the ego is generated with the help of capacities related to motion and action. Husserl adopts the expressions "kinesthetic sensations" and "kinesthetic sequences" to refer to the subjective awareness of posture and of motor aspects to the aim of differentiating them from the position and motor aspects of the perceived things in space.

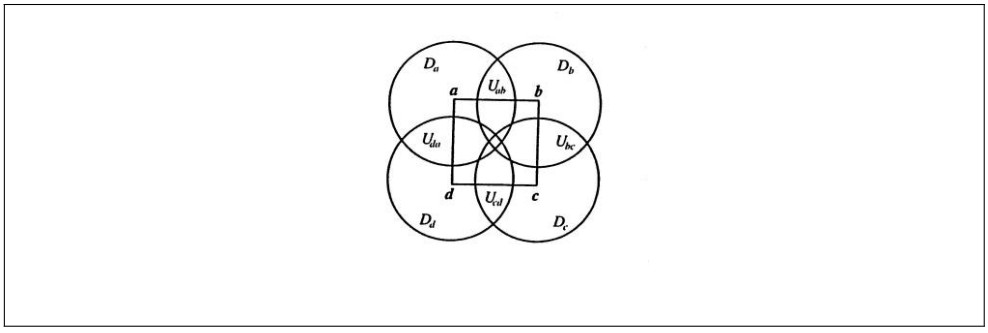


Figure 1: Scanning square *S* with corners *a*, *b*, *c*, *d*. To each position *p* corresponds a token *Dp* of the visual field *D* centered on *p* (focalization on *p*).
The neighboring *Dp* overlap.
Source: Petitot et al. (1999)

Husserlian phenomenological architecture goes ahead using eidetic descriptions that fa- vor the description of the objective space. With the help of very sophisticated Husserl is able to explain the realization of the objective measurable time and of the space characterized by stereopsis, three-dimensionality and three-dimensionality of objects embedded in it. The phenomenological sequence, that is granted by two-dimensional gluing

and stereopsis, can interestingly be reversed: in this way the visual field becomes part of a surface in $\mathbf{R}^3$. In this last case the objective constructed space exhibits an apriority, a precedes the things as they are naturally and instantly given by a plain connection: space presents itself as an apriori datum which exhibits to the human agent the external environment in which objects are present and endowed where finding objects in the perspective of their extensions and references. In this reversed picture of the phenomenological process, also the adumbrations result from the objective three-dimensional space, as the "flood" of transmutations of two-dimensional images emerging from a thing seen as inserted in the spatiality of $\mathbf{R}^3$. Also nonlinguistic cognitive capacities of some animals are exploiting adumbrations as tools able to make objective entities of various type, for example when committed to the "thingification" and to the subsequent creation of a kind of "concept" (and of "pseudothoughts").

3.2. Adumbrations are Abductive Anticipations

Adumbrations, the center of gluing processes that originate the two-dimensional space, con- stitute an infinite multitude, but of course the possible co-givenness of some of them, that is of the ones that refer to the same object, are limited. The partiality of their way of referring to a certain object requires the completeness of the process, which can only occur in a tem- poral dimension. Adumbrations can be depicted also at the level of imagination and always constitute, being incomplete, *anticipations*: when we see a geometrid solid shape from one angle (as an adumbration), we are disposed to guess it is actually a cube, but it could be also a rectangular cuboid.

Anticipations share with visual and manipulative abduction many aspects: they are highly hypothetical and nonmonotone, so incorrect anticipations must be substituted by other more persuasive ones. We can generate them and later on test them, of course thanks to manipulative acts in which kinesthetic controls and manipulations of external entities are involved. Adumbrations also offer different degrees of information and surely function as attractors for the individuation of preferred entities. The aim is to reach "the best anticipation".

Following the process typical of *selective abduction*, first of all anticipations select potential routes for reaching the determination of objects, "reifying" them among the several that remain hidden. Secondly, following the process typical of c*reative abduction*, they can provide novel perspectives of combination, so leading to the individuation of new object-s/things. In this case they make origin to notable "attractors" that in turn

can originate *new* "conceptual" generalizations. So to say, the Husserlian phenomenological understanding of the production of "idealities" makes us aware of the origins of the final result of the process, that s the space as an objective "fact", established in such a way that cognitive agents like us face an external world in which entities/objects can be found from the perspective of their referentiality and extension.

I have to finally add that Husserl's philosophical intuitions are being further deepened by neuroscience and many other parts of cognitive science studies. For example, Grush's emulation theory (Grush, 2004, 2007) exploits a control theory in which forward mod- els as emulators (in both humans and several animals) are borrowed to describe various human cognitive processes like perception, imagery, reasoning, and language.

3.3. The Activity of "Reading Ahead" and Anticipations

After having shown the phenomenological philosophical narrative that illustrated how we arrive to face our external environment with its entities as mere references and extensions, sedimented in centuries of cognitive activities of our progenitors, we can now afford the problem of detecting which are the cognitive abductive activities (strategies) that occur in the *extra*-phenomenological situation of the moves in the artificial (human-made) board game Go. Are they unlocked such as in the case of the strategies analyzed by Husserl? Are they instead locked? If so, what is the meaning of locked strategies and the consequences that this concept causes in the case of the description of human and machine capacities? A game like Go presents two players, who exactly as in the Husserlian phenomenological investigation, are still characterized by visual, kinesthetic, and motor sensations and acts, but also by visual, iconic, and sentential representations (both internal and external), that play a dominant role.

I just said that the game Go is an *artificial*—human-made—game that contemplates two players and their natural and artificial (cognitive) environments. It is not comparable to the *natural* game between human beings and their prepredicative surroundings of the phenomenological situation described in the previous subsections. However, we can find in game Go something similar to the role of adumbrations and anticipations, exactly in the moments of the game in which human players' moves generate more or less critical changes in the surroundings—that is board, stones, and various possible auxiliary and permitted assisting equipment.

The main capacity that characterizes the tactical player is the efficient ability to *read ahead* [that is to *anticipate*], as the Go players usually say. Reading

ahead can be reasoned or intuitive (or mixed), but in both cases it includes a sophisticated cluster of several types of anticipations which regard:

1. applicable moves to play and their possible outcomes. In Husserlian terms we can establish that a given situation of the board at a certain time consists of an adumbration of a further potential more favorable situation at a subsequent time, which indeed is the fruit of a plausible abductive hypothesis: based on this hypothesis another ab- duction is selected and operated, which—consistently and reasonably—produces a specific move that can support the generation of a projected more favorable situation;

2. potential answers to each move;

3. consequent opportunities after each of those answers. Some of the more expert players of the game Go can read up to 40 moves ahead even in extraordinarily complex positions.

In these types of scenarios concerning artificial games, the empirical objects (stones and board), in their successive formats, are the results of cognitions "sedimented"—an explanatory expression still adopted by Husserl—in their embodiment. Indeed these cognitions come from the use of the conventional rules but are also derived thanks to the individuals' cognitive capacities owned by the two participants, in terms of strategies, tactics, heuristics, etc. and are sedimented in those observable objects (artifacts, in this case) that consequently function as *cognitive mediators*. For example they limit players' lucubrations, transfer in- formation, and mediate further cognitive opportunities. Mental modifications of each of the successive board situations, appropriately represented internally, are further constructed, to the aim of producing the next rewarding move.

At this point it is important to clearly say that the strategies that are used are various but always "locked", because the elements of each scenario do not change and are always the same. Of course during the game the disposition and the number of stone change but this happens in a fixed framework. It is obviously forbidden and impossible to add new rules, new objects, boards of different shape and size. In summary, it is forbidden and impossible to take advantage of different kinds of knowledge and information, deriving from sources alien to the given scenario.

In the following section I will illustrate that the concept of *locked strategy* is extremely useful to analyze the limits of machine cognitive capacities such as AlphaGo, the deep learning program able to play Go. As for now a final observation is mandatory. The concept of locked strategy establishes a categorization that is unrelated to other more specialized ones that belong to game theory.

4. Artificial and Computational Games: Locked Cognitive Capacities Characterize Machine Abduction

4.1. Locked Abductive Strategies Jeopardize the Eco-Cognitive Openness

We have said that abduction is knowledge-enhancing when new generated knowledge is reached at various novelty levels, without the help of empirical confirmation: for example a successful diagnosis in the case of a medical patient (selective abduction, no new biomedical knowledge is found) or new concepts and theories in the case of scientific discovery.

Of course the strategies used to arrive to selective or abductive results have to be very efficient, but it is also important to be inserted in cognitive surroundings characterized by what I have called *optimization of eco-cognitive situatedness*, in which eco-cognitive *open- ness* is very often central (Magnani, 2016). In the subsection 4.2 below I will illustrate a preliminary result: to promote especially good creative and selective abductions cognitive strategies have to be freed from constraints, that is strategies do not have to be "locked" in external fixed (one and forever) eco-cognitive surroundings, such as it is occurring in Go game, in which there is a scenario characterized by definite rules and finite material objects, which would work as the only fundamental cognitive mediators capable to enforce human agents' reasoning.

A short explanation of the expression *eco-cognitive openness* has to be provided. In my recent studies about the so-called *naturalization* of the logic of abduction (Magnani, 2015b) I emphasized the relevance in good abductive performances of what I called (Magnani, 2016, 2018), *optimization of situatedness*. Let us consider the importance of abductive cognition in scientific creativity, one of the most valued aspects of the production of human rational knowledge: a minimal epistemological requirement able to favor its success surely resorts to the presence of a good cognitive situatedness of the reasoner in an open cognitive environment. The research permitted the following result: situatedness is linked to eco- cognitive aspects and related to the several situations in which knowledge is

"traveling". In many abductive contexts, not only in scientific creativity, the abundance and quality of the flux of information has surely to be favored (even maximized, sometimes).

4.2. Locked Inferences Impair Creativity of Deep Learning Computational Programs

I have illustrated above that to promote satisfactory creative and selective abductions inferential strategies must not be "locked" in external constrained eco-cognitive surroundings (characterized for example by a scenario determined by definite rules and finite unchangeable entities/objects as cognitive mediators). In subsection 3.3 I adopted, as a paradigmatic example of a weak scenario in which eco-cognitive openness is jeopardized, the game Go (but we could also consider Chess or other games). In these games stones, changes of board L and rules are strictly determined and so they do not present a surprise, only the inferential strategies "can be" various and unpredictable. They are learnt by the players during years of games and produced (already used or new ones) also reflecting upon the modalities that the contenders are using to play the games. An expert player certainly possesses a rich mental repository of strategies he learnt in a plenty of antecedent games and when attending other games plaid by other contenders.

Consequently, as I have already indicated, the inferential strategies and the contender's ones are always *locked* in a rigid scenario: it is not possible, to provide a fictitious example, that when you are making a Go competition, you can play for some minutes Othello or another game, or you execute a different external cognitive procedure, affirming that those exotic portions of the game you implemented are still valid as parts of the Go game you are playing. In sum, a different scenario cannot be considered to the aim of *unlocking* the strategic reasoning related to your extended human capacities, because for example you are candidly convinced that this will enhance your chances of winning. In the case of an artificial game like Go the opening of the eco-cognitive settings is not a free choice of you: on the contrary this is totally legitimate in the case of scientific discovery, in which it is normal— for example—to take advantage of variegated external "models" to make analogies or to favor other cognitive strategies (prediction, simplification, simulation, confirmation, visualization, diagrammatization, thought experiment, etc.) to support the abductive creative process.

The example of Go game deals with a weak cognitive situation, if seen in the light of eco-cognitive openness. Strategies are variegated and

possibly infinite, but *locked* in rigid surroundings in which the elements cannot be altered or modified (the stone on the board can just be reduced). I contend that these kinds of rigid scenarios constitute a form of *autoimmunization* (Arfini & Magnani, 2015; Magnani & Bertolotti, 2011) that impedes the application of inferential strategies to not pre-configured knowledge data, foreign to the ones already inserted in the established entities of the rigid scenario. I have already explained that these entities work as *cognitive mediators*, which impose serious limits to the whole cognitive process of the game.

The consequences of the role played by the locked strategies that regard the cognitive cases of creative and selective abduction in both human and machine capacities can be described and summarized in the following items:

1. contrarily to the case of sophisticated "human" creative inferences (that is creative abductions) such as for example the processes embedded in scientific discovery and in other situations in which extraordinary intellectual accomplishments are at stake, the cognitive status of artificial games is very weak from the perspective of the *non-strategic knowledge* concerned. We are dealing with stones, scarce rules, and a board. The scenario changes during the struggle between the competitors but no new cognitive mediators (basic entities) appear. We cannot expect—of course in the same game—to see stones presenting a different shape or color, or to use a hexagonal board in a new game. Epistemological research has instead taught to us that, first of all, scientific cognition (for example in empirical disciplines) takes advantage of copious empirical sources and evidence, possibly further enriched by the presence of "new" aspects (they are not merely changes of the conformations of the standard entities, as in the case of artificial games, but unexpected data, for example anomalies). Secondly, the knowledge concerned is extremely rich, and contemplates analogies, thought experiments, models, imagery, mathematical schemas, etc. that can come from various fields of knowledge, not necessarily scientific. This means that in science we face an intellectual environment of open eco-cognitive situatedness.
2. also the case of the role of environment in selective abduction is interesting. Medical diagnosis is a paradigmatic case: first, "evidence" spontaneously arrives from variegated "founts", the empirical ones

that concern somatic data but also mediated by technological artifacts (step after step rendered more reliable and fruitful thanks to the progresses of normal science devoted to technological innovation). On the contrary the repository of hypothetical knowledge in which selective abduction works is instead *locked*—medical diagnosis consists in "selecting" from a collection of pre-established diagnostic entities. However, also at this level new scientific biomedical advancements can enhance the encyclopedia of diagnostic hypotheses. Finally, new cognitive strategies and related heuristics can be generated and old ones used in new unpredictable ways: however, it is fundamental to note that strategies are not locked. In sum, the creativity involved is of a weaker level with respect to the one active in scientific discovery, but much ampler than the one that we have seen at work in the locked cognitive strategies of the artificial games;

3. in the human cognitive capacities involved in artificial games in which reasoning strategies are "locked", unfortunately only strategical cognitive processes can be enhanced: new ones can be created and old ones can be exploited in novel ways. Anticipations as abductions (which concern the cases of "reading ahead") of the players just affect the rearrangement and re-design of the same entities.
4. the reader that is interested in the status and richness of locked strategies in games can refer to the recent logical perspective proposed by Park (2018), which takes advantage of the theory of enthymemes advanced by Paglieri and Woods (2011a, 2011b). Park sees each move and so the strategies adopted in Go and AlphaGo games as exhibiting an enthymematic argument which privileges parsimony over charity. It is parsimony rather than charity the driving force of enthymematic argumentation embedded in Go games, especially in the computational case, in which the evidence that strategies are so strong and overwhelming (with the respect to the human ones) resorts to the fact that "One of the important factors that might uncover the secret of success of AlphaGo can be found in its capability to present and evaluate enthymemes" (Park, 2018, p. 1163).

5. the reader must not misunderstand me, I am not underestimating the human cognitive capacities that are involved in games: the centrality of the role of cognitive strategies is the main attraction of Go, Chess, Othello and other games, and also reflects the magnificence of the skilled decisions of the champions. However, we do not have to obliterate the fact that it is exactly this centrality that explains the lower creativity involved, even with respect to the case of selective abduction (diagnosis). I will soon illustrate that this is the reason that explains why the cognitive capacities involved in human games can be more "easily" rendered by artificial intelligence computational systems than other processes of human creativity, such as scientific discovery or many cases of diagnostic reasoning.
6. classical philosophy already clearly stressed the role of what I call eco-cognitive openness in creative abduction. Indeed Aristotle in his foundational studies on ab- duction, stressed the relevance of non locked, but totally open, cognition, in the celebrated passage of the chapter B25 of *Prior Analytics* concerning *apagoghé* ("leading away"), also reassessed by Peirce. The special (and correct) translation in English of the Aristotelian word *apagoghé* with "leading away" (instead of abduction), already represents in itself the importance of cognitive openness in this kind of reasoning.

It is clear that human knowers involved in the abductive reasoning processes I have just examined have to be seen as embedded in a typical distributed cognition framework: this explains why the two concepts of model-based and manipulative abductions are fundamental. Moreover, the abductive cases I have illustrated also insistently show that the "situatedness" of the cognitive acts involved lowers or enhance the eco-cognitive openness, depending on the context. Some portions of reasoning, if locked, cannot take profit from novel and heterogeneous pieces of knowledge.

As I have already said, I do not want to underestimate the relevance of cognitive strategies in Go and in board games. Holland (1995, 1997) observed that board games such as checkers, Go, etc., show the role of "emerging" processes, where potentially infinite chances emerge and give origin to an impressive quantity of novel and unpredictable strategic moves, simply starting from a simple set of rules. We can speak of "vertical" creativity, which regards unlocked reasoning, and of "horizontal" creativity which illustrates the case of board games. These are certainly locked by the several active constraints, and nevertheless "horizontal" creativity can arrive to astonishing degrees of complexity on the basis of simple rules. It has been

positively simulated by artificial intelligence programs (cf. the following paragraph), so astonishing that they were considered an unquestioned human achievement for many decades and new artificial intelligence programs have been proposed that are able to *learn from* human games. At this point the question we have to answer is the following: what are the important consequences of our distinctions between locked and unlocked strategies when we have to analyze the cognitive status of computational AI programs created to the aim of executing cognitive abductive processes? In the following paragraphs we will see that in recent *deep learning* computational programs strategies are locked and we will describe the cognitive and epistemological consequences of this conclusion.

5. Conclusion

Thanks to the concepts of knowledge enhancing abduction, adumbration, anticipation, optimization of eco-cognitive openness, I have described some fundamental characters of hu- man and machine capacities from the point of view of the distinction between locked and unlocked strategies. I also exploited my *eco-cognitive model* (EC-model) of abduction, which is in my opinion particularly fruitful in depicting the abductive status of the concept of anticipation in human cognition, as it is described by the Husserlian phenomenological tradition, interested in the generation of spatiality and idealities. Anticipations are central to permit to understand the role in the genesis of space of the *Abschattungen* (adumbrations). These indeed play the role of abductive anticipations: I have illustrated that anticipations can be fruitful studied as cases of visual and manipulative abduction, to the aim of furnishing a synthetic analysis of two kinds of strategic reasoning, *locked* and *unlocked abductive strategies*, active, respectively, in human and machine capacities and fundamental in the basic cognitive procedure of "reading ahead". I have also illustrated that this dichotomy is in my opinion crucial in showing important aspects of abductive creativity in deep learning computational programs such as AlphaGo and in human inferences, and their differences. Locked abductive cognitive strategies are easily reproduced computationally but are con- strained in their creative potential because refer to "pre-packaged" scenarios, contrarily to the case of inferences that are occurring in unlocked environments characterized by what I called *eco-cognitive openness*.

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