Ignorance-Based Chance Discovery

Beyond Dark Events

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Abstract

The human part of chance-discovery is usually analyzed as an effect of the agent's knowledge of herself and of her environment. In this paper, setting off from the importance of "understanding the meaning of an impending phenomenon as a chance," we will analyze how chance-discovery activities are affected and driven by the agent's ignorance, and the relationship she entertains with the latter. More specifically, we will spell out two kinds of ignorance that are relevant for chance-discovery, also considering which abductive chance-discovery processes they can be related to.

Keywords: Human Computer Interaction; Chance-Discovery Methods; Abductive Reasoning; Affordances; Ignorance

Chance Discovery and Relevant Knowledge: Agents, Environment and Affordances

Chance discovery (and related processes such as chance curation) are defined as the fact of becoming aware of and understanding the significance of a chance: a chance is simply "an event with significant impact on a human's decision making" (Oshawa & McBurney, 2003; Maeno & Ohsawa, 2007). (Ohsawa & Fukuda, 2002), describing "three ways to chance discovery", explore as the first way "Human as the Main Part of Chance Discovery." Albeit chance-discovery is a human-computer collaborative process, we will set the focus on the human part, exploring the inferences that allow human beings to rely on environmental chances. Hence, we will proceed to analyze, within an eco-cognitive frame (Magnani, 2009), the role of human ignorance in chance seeking processes.

An interesting list of features comprehending the human part of chance discovery is presented by (Maeno & Ohsawa, 2007, p. 1184): a) having a particular interest; b) understanding the meaning of an impending phenomenon as a chance; c) putting a scenario based on a selected chance into a concrete shape; d) running a simulation or taking an action based on the scenario; e) acquiring a new interest.

Our reflection in this paper will be centered on the interplay between items a) and b), and especially the second one. The "particular interest," indeed, and the capability to understand the "meaning" are crucially influenced by the agent's knowledge and ignorance. Thus, our goal will be to show how not only the agent's knowledge but her ignorance as well is pivotal in the discovery of new chances: namely, we will explore to which extent the second item of the list, *understanding the meaning of an impending phenomenon as a chance*, can be warped and still maintain us within a chance-discovery framework. In order to do so, we will first briefly recapitulate some cognitive and inferential architectures that enable humans to perform chance-discovery activities (namely affordances and abduction); then we will analyze the impact of ignorance within those cognitive architectures – and how it affects chance-discovery especially as far as Maeno and Ohsawa's "dark events" are concerned.

In this section we will briefly recapitulate two cognitive and inferential architectures that are crucial in understanding the human part of chance-discovery. We will also elaborate how they both concern human beings as knowledge carriers, yet in the following section we will argue that part of the chance-discovery process relies on human beings as carriers of ignorance.

Affordances and Chances

As claimed by eco-cognitive epistemology (Magnani, 2009), by promoters of the extended cognition paradigm (Clark, 2008) and cognitive niche theorists (K. N. Laland & Feldman, 2006), humans (and some animals) manipulate and distribute cognitive meanings after having delegated them to suitable environmental supports. This perspective, strongly situating human cognition and decision making within their environment, has already been successfully applied to the framework of chance-discovery (Magnani, 2005; Magnani & Bertolotti, 2013). The activity of cognitive niche construction reveals something important about human and animal cognitive systems. One of the main tenets of this approach is that humans do not retain in their memory an explicit and complete representation of the environment and its variables, but they actively manipulate it by picking up information and resources upon occasion. Information and resources are not only given, but they are actively sought for and even manufactured. In this sense, human cognition per se can already be described as performing activities of chance-discovery, which in turn can

be dramatically increased by computational collaboration. As already argued (Magnani, 2007), chances – understood as events with a "significant impact on a human's decision making" – are data, or clusters of data, bearing a strong affinity with the concept of *affordance*, introduced within Gibson's ecological psychology (Gibson, 1977): it is thus possible to rely on such concept in order to better understand the human part of chance discovery.

Gibson defined "affordance" as what the environment offers, provides, or furnishes. For instance, a chair affords an opportunity for sitting, air breathing, water swimming, stairs climbing, and so on. It is important to stress that the notion of *chance* and that of *affordance* are not mutually interchangeable. While it could be said that all chances – as relevant for one's decision making (and hence one's behavior) – are affordances, conversely not all affordances rise to the level of chances. It is nevertheless possible to elaborate on a shared characterization of affordances and chances, in their setting a relationship between an agent, her knowledge, and her environment. Considering the debate between the immediate or mediated nature of affordances (Magnani, 2009, chap. 6), and consequently whether they can be learned or not, chance-discovery could embody the natural follow-up to affordance theory: chance-discovery is indeed about the discovery/construction, via a human-computer interaction and through effective procedure of data analysis and crystallization, of new complex affordances (clearly learnt and mediated), offering unforeseen possibilities for decision making and action.

Chance-Discovery and Abduction

The human part of chance-discovery, which we claim is partly illuminated by human beings' ability to perceive, pick up and employ environmental affordances, refers to two important aspects that concern the agent's *knowledge*. First, finding/constructing affordances, or discovering chances, deals with the possibility of understanding certain data as meaningful. Exactly as postulated by Maeno and Ohsawa, it is about being able to "*understand the meaning* of an impending phenomenon as a chance." Second, and following from that, the emergence of some data as meaningful as a chance depend on the specific *eco-cognitive interaction* between a specific agent and her environment (be it a physical environment, but also an informational one): the possibility of such emergence seems clearly linked to the person's *cognitive endowments* and to her *knowledge*. As already contended by (Magnani, 2007), the individuation of an affordance, just like that of a chance, is an inferential process best framed by the epistemological notion of *abduction*, here describing the process of individuating, in an array of data, which are highly symptomatic of the presence of a chance.

Abduction is a process of *inferring* certain facts and/or laws and hypotheses that render some sentences plausible, that *explain* or *discover* some (eventually new) phenomenon or observation. The introduction of abduction in the discourse may clarify some puzzling issues proposed by Gibson, especially the claim concerning the fact that we directly perceive affordances and that the value and meaning of a thing is clear at first glance, and consequently let us fully benefit of the affordance-theory as a theoretical tool to understand chance discovery. As far as affordances are concerned, organisms have at their disposal a standard endowment of affordances (for instance through their wired sensory system, which is the only cognitive system "available" in the case of simple organisms), but at the same time they can extend and modify the range of what they are afforded by through the appropriate cognitive abductive skills (more or less sophisticated). This is especially the case with human beings, and perfectly translates as far as it concerns chance-discovery. As maintained by several authors (for example cf. (Magnani, 2009)), what we see is a result of an embodied process of abductive cognition. For example, humans are exceptionally skilled at imposing order on various, even ambiguous, data, which coincided with one of Peirce's description of abduction.

Magnani has already proposed a fuller description of the strict relationship between chance-discovery, affordance-perception and abductive cognition (Magnani, 2007), but it is worth adding how the abductive framework does not only account for the human inferential engagement in chance-discovery, but also for the computer-based counterpart: the *information artifacts* (Amitani & Hori, 2004) or *cognitive artifacts* (Shibata & Hori, 2004), which represent the multiple external tools - communication, context shifting, computational devices expressly constructed to the aim of creating opportunities and risks, like KeyGraph, etc. - recently analyzed by researchers in the field of chance discovery (Oshawa & McBurney, 2003), can be analyzed in a distributed-cognitive perspective as integrating the human chance-discovery activity through the replication of abductive patterns. Consider the methodology for the discovery of hidden chances (dark events) proposed by Maeno and Ohsawa (Maeno & Ohsawa, 2007): the employed technique of *data annealing* is the informational counterpart of a physical procedure aimed at improving the workability of a material by a manipulative process.

> Annealing in materials science is a heat treatment where the structure of a material is altered. [...] Similarly, simulated annealing is a probabilistic technique of computational optimization based on physical formulas describing the annealing in materials science. [...] The human-computer interactive annealing is similar to the annealing in materials science and simulated annealing (p. 1186).

The physical manipulative process is transformed into a human-computer interactive manipulative process, in which the object of the informational search is obtained through a series of computer-generated annealing steps and then sorted out by a human agent, and in turn processed by the computer, until the dark event, which is the hidden chance affecting the whole system, finally emerges: this is an extremely interest-

ing process of chance-discovery inasmuch as it displays an integration of *manipulative* and *selective* abductive steps, interchangeably performed by the human or the computer. Maeno and Ohsawa's methodology is of crucial importance for our analysis since the quest for "dark events" – that is latent structures that diffuse into the system, invisible and yet affecting the system itself – allows for the introduction of the topic of *ignorance*, complimentary to that of knowledge, in the framework of chance-discovery.

Abduction, as an inferential process aiming at finding out explanatory information starting from a cluster of data, concerns indeed the passage from what is known to what is not known yet. This can be a hidden event, or chance, either regulating the system or which can be exploited to operate on the same system. Consider the standard three-steps exemplification of abduction provided by C. S. Peirce: *1) The surprising fact C is observed. 2) But if A were true, C would be a matter of course. 3) Hence there is reason to suspect that A is true.* The abductive inference allows for hypothesis C to be moved from what is not know, i.e. one's ignorance, to what might be the case. In the example of dark-event discovery proposed by Maeno and Ohsawa, the method of annealing and selection could allow for the emergence of the structure of the hidden command line in an organization, or of an item within a marketing setting that shifts the consumers' preferences.

In these cases, the type of abduction instantiated by the chance-discovery mechanism is a *selective* one, because the event – albeit previously unknown – is expected within an array of possibility-tokens, or still a possibility-type. In such cases, as postulated by the second item in the aforementioned list, what is crucial is the agent's capability of *understand the meaning* of an impending phenomenon as a chance: that is to say, she is able to recognize and select the event, or chance, she is looking for. This kind of abduction is differentiated from the *creative* one in which the desired hypothesis, or explanation, is not selected among an array of available ones, either as tokens or as types, but created altogether: it is often the case of creative scientific hypotheses about new laws or theories. As regards the detection of dark events, it could be said that the development of Maeno and Ohsawa's methodology is the output of creative abductive reasoning, while its functioning embodies a selective abductive process.

Eco-cognitive abduction, central/peripheral information, and the role of ignorance in chance-discovery

So far we have shown how chance-discovery works in relation with the perception of affordances, and how it can be guided by abductive reasoning as a knowledge-based discovery process. As often argued, the detection of new chances is analyzed as the *recognition* of events, or pieces of information, from a given set of data that are already available (either as tokens or as a category) to the human agent. In this case, the manipulation of the environment helps the search because of the novel configuration of the affordance-perception, which improves the discovery of chances among them. Now we are going to introduce how not only the management of affordances (and chances) that are available to the subject is guided by her degree of ignorance – and not solely by that of her knowledge – but also that chance discovery processes, especially the abduction-based ones, are a task of *searching into one's ignorance*, which can be extremely more productive if the agent is aware of it.

As far as "understanding the meaning of an impending phenomenon as a chance" (Maeno & Ohsawa, 2007) is concerned, it is comprehensible how "understanding" can be used as a synonym of "learning", that is apprehending the potential of data that are present, even if still unnoticed until reached. The presence of data is required in order to organize the role of the agent in the process: her aim is – as Ohsawa and Fukuda pointed out – to *become aware* of a chance and to explain its significance, considering the chance as a piece of information about events or situations that is significant for decision making (Ohsawa & Fukuda, 2002). Nevertheless, the issue regarding chance-discovery is not the presence of the chance, its availability to the agent who is looking for it, but the "*unnoticed yet*" quality that makes it so valuable. This feature makes chance discovery methods crucial in order to improve areas of knowledge such as the relationship between an agent and her environment. Hence, if the discovery of chances involves the emergence of a certain awareness about the unexpected significance of information about data or events, the state of the agent can be considered as, at least, *partially ignorant* about that significance until it is reached.

Nevertheless, while the knowledge-generating processes are usually studied in order to provide models for chance discovery, the issue concerning how and what kinds of *ignorance* interact with those knowledge-generating processes is unsurprisingly overlooked. In order to provide a model involving the role of ignorance in chance discovery processes we are going to adopt parts of the "Bubble Thesis" that Woods illustrated in 2005, that implies an ignorance-based model of our most basic cognitive processes, such as believing (Woods, 2005).

Setting off from the Peircean description of the attainment of belief – which placates doubt – as the sole function of thought, Woods' *Bubble Thesis* principally aims at comprehending the actual relation between the complex of beliefs an agent has and her awareness (or lack thereof) about their correctness or unsteadiness. The outcome of this process is called *epistemic bubble*: a *first-person knowledge-ascription*, performed by the knowing agent, to whom the difference between *knowing* something and *thinking that she knows* that same thing is unapparent – and the tension that may arise is always solved in favor of the former (Woods, 2005).

An epistemic bubble containing the piece of information is a model by which we can confirm that the cognitive confidence of the agent concerning her possession of information is not completely related to the actual attainment of the information itself. In other words, we can contend that any first-

person knowledge-ascription is characterized by a certain *degree of illusion* – embodied by the human agent – about the completeness of the knowledge the agent thinks she possesses or her perpetual possession of the entire piece of information. Absurdly, while the agent can afford an almost perfectly clear third-person perspective view on someone else's information possession, she cannot be aware of this matter when she has to judge her own beliefs.

Obviously, the *first-person knowledge-ascription* (from now on FP-KA) can incorporate a smaller or larger degree of illusion, depending on the type of information, its portability and completeness, the interest of the agent and her psychophysical state. Still, we are interested in how the hidden parts of information, which our cognition does not contemplate in the knowledge ascription, can turn out to be *possible hidden chances* set out of our reach. As it regards the second human feature of chance discovery, "understanding the meaning of an impending phenomenon as a chance" (Maeno & Ohsawa, 2007), such *becoming aware* can be understood if we talk about the recognition of a chance in the zone that the agent ignores, that is to say where the degree of illusion is rooted.

The degree of illusion of the FP-KA has an impact on the method of chance discovery that we can adopt, but it should be noticed how the degree of illusion does not necessarily match the degree of accuracy of the FP-KA. The two levels, as always, depend on the cognitive environment the agent moves into, and on the affordability of the different pieces of information she can count on. The dominion of expertise of the agent is set on the information about which she has a high degree of FP-KA and a low degree of illusion, i.e. the knowledge she ascribes herself almost corresponds to what she really knows. We could see the complex of data an agent possesses, together with those that is within reach in her cognitive environment, as an agent-centered system. Her topics of expertise correspond to the *central information*: she can easily reach them and her ignorance about them is minimal. Instead, the information that still is within the agent's cognitive system but that is not in her dominion of expertise, or that she is broadly ignorant about, correspond to the *peripheral information*: she knows something about it but it is not part of her practical knowledge field. This analysis can be extended to a particular kind of eco-cognitive information, that is chances.

So, a peripheral chance refers to some information requiring a high degree of illusion in order to be *thought as possessed* by the agent, and which has a scarce influence on her actual decision-making. In fact, the agent may think she knows little about this information, but she knows even less than that. As we can see all information, affordances and chances included, involves a part of rightful FP-KA – in the matter of affordability of the data and the degree of expertise of the agent – and a part of illusion about the availability or competence about them. The distinction between central and peripheral information, as we saw, is an effect of how an agent's cognition is indeed an eco-cognitive performance, which sees no sharp division between the information (and lack thereof) stored within her brain and what is available in her cognitively meaningful surroundings. It is crucial to differentiate between central and peripheral information inasmuch as it leads to the individuations of a subdivision in what is commonly referred to as "ignorance," which will – in turn – prove extremely useful in spelling out two different chance-discovery methods.

At this point, we can use yet another feature of abductive reasoning to understand how to reach (and discover) those chances that lie on the ignored side of the agent-centered system. Indeed, abduction is a procedure in which something that lacks epistemic virtue is accepted because it has virtue of another kind; by saying so not only they referred to the fallacious nature of abduction, but also to the fact that it presents – as Magnani showed – "an ignorance-preserving (or, better, an ignorance-mitigating) character" (Magnani, 2013). In fact, even if abduction constitutively is a response to an ignorance problem (in this case chance discovery), its structure can be modeled as a carrier of a complete knowledge-enhancing solution, so that it can be direclty classified as an *inference to the best explanation*. In this case the supposed hypothetical-provisional and ignorance-preserving character of the discovered solution is obliterated: abduction instantly provides the best solution, without any kind of evaluation (for example empirical).

In the context of a chance discovery process guided by abductive reasoning, there are two kinds of ignorance that remain preserved:

1. The ignored possibility of other existing chances in a well-known environment, i.e. within the many kinds of central information the agent possesses. They are part of the agent's eco-cognitive system and they would enrich her knowledge (in the matter of decision-making) on a particular – and already investigated – topic. They are often already tacitly affecting the decision-making processes of the agent but, given that they are part of a well-known field, they are extremely hard to find and spell out. Discovering these chances is effectively about "understanding the meaning of an impending phenomenon as a chance;" so, as we will show, they can be seen as the "dark events" presented by Maeno and Ohsawa (Maeno & Ohsawa, 2007).

2. The ignored possibility of the existence of any kind of chances in a field the agent is quite unaccustomed with, that is in the agent's peripheral information. Since they belong to some topics that are relatively unknown for the agent, they are easier to find than the previous ones, but their significance as chances can be harder to understand. In this case – as always using the second feature of chance discovery method presented by Maeno and Ohsawa (Maeno & Ohsawa, 2007) – there is a *lack* of understanding of the meaning of an impending phenomenon (that the agent ignores) as a chance; yet once that phenomenon emerges

from the peripheral information, it sparks awareness about the *possibility* of being understood as a chance. We will present this type of chances as a richer and further "dark event."

Abducing from ignorance: two methods of ignorance-based chance discovery

The two kinds of ignorance we just spelled out can be investigated through the two types of abduction we have introduced before: the selective abduction and the creative one. The first type of ignorance is set within the limits of the agent's cognitive environment. It is grounded on her own central information and it involves the part of illusion about the actual knowledge the agent has on her field of expertise. That is, it requires a specific question to be grasped and so the agent's awareness about her own lack. When the illusional FP-KA is compromised, the agent becomes aware of the information she lacks: what she needs to solve her problem becomes clear – and so how to manage this lack. This specific kind of ignorance is, indeed, defined through the agent's knowledge. Then, when a chance appears inside of this ignorance it is understandable as a chance: the agent, often, is already looking for it and the richness of this kind of opportunity (or risk) depends on the agent's interest. In order to characterize this type of chance, we can say that it appears to be structurally similar to the "dark event" described by Maeno and Ohsawa which "is not visible. The occurrence frequency is very small. It diffuses randomly like an atmosphere because it neither tends to cling to a particular event cluster nor tends to appear as a pair with a particular event." (Maeno & Ohsawa, 2007, p. 1186).

In order to grasp this kind of chance, the agent can enact a *selective abductive inference*. It gives the agent the possibility to inquire into her specific ignorance and find the *best explanation*, selecting it from a known number of choices (or still within a type of possible choices). The hypothesis will not only preserve the ignorance about the unforeseen possibility that the chosen hypothesis could be less than the best possible chance (and thus letting the chance show its distinctive trait of being either an opportunity or a risk), but it will also preserve, or recreate, the degree of illusion about the FP-KA concerning the newly discovered chance. The new chance can be understood on the base of the agent's knowledge system, so she can use her fallacious (but effective) cognitive recognition to grasp it as a part of her system, and adapt her decision-making process to its discovery. Obviously it is an enhancement of how she manages her eco-cognitive structure, but it is already an active part of her decision-making: as suggested, the agent has only to become "aware of it", in order to name it as a chance.

Let us make this process clearer by referring to an actual example: consider the development of the two latests iPhones by Apple as a chance-discovery process elaborated on an already well-known system. The developers used the same iOS operating system, but in order to make their smartphone more appealing and more affordable to younger generations, they created the iPhone 5C model, cheaper than the iPhone 5s (and their predecessor, the iPhone 5), with a colorful plastic shell and a plastic screen (which are also less prone to cracking than the glass one of the 5S). They had three problematic issues to tackle and they improved them basing on the fact – once ignored – that the iPhone was expensive, it had a colorless cover and its shell would last less than what young consumers – for whom it is designed – prospect. Together with these problems they selected an alternative to make it better and, using the smartphone's appearance as a mine of chances, they released a cheaper and less imposing version of the iPhone. The changes were indeed very little, they did not change any of the iPhone's substantial traits, but they solved specific problems. In the view of Apple engineers, the release of the new, "low cost" model was meant as a chance, an event able to significantly modify the decision-making processes of a new consumership: whether this was a success, it is still debated almost a year after the release of the iPhone 5C, further corroborating the dual opportunity/risk nature of a chance – whose settlement sometimes heavily depends on the perspective the chance is evaluated from.

Making chances emerge from ignorance: creative abduction and chance-discovery The second type of ignorance is harder to manage than the first. It does not require just a specific question to be inquired, and so discovered. Since it concerns peripheral information, it does necessitate more than the agent's ordinary expertise in order to be understood: rather, it requires more patience and resources to be integrated with the central information. In order to discover a chance inside this kind of ignorance it becomes necessary to change the eco-cognitive system of the agent and enhancing it with the perspective that even in zone with peripheral information there still are plenty useful chances to discover. It also involves a changing into the direction of the *interest* that it supposed to guide the chance-discovery process. In this case, there is no possibility to use a selective abduction to direct the inquiry within such a vast and problematic ignorance. The method that can shed some light is Magnani's aforementioned *creative abduction* (Magnani, 2009).

Creative abduction does not provide a simple selection of hypotheses but, through the change of the eco-cognitive paradigm the agent is in, it provides a brand new field to investigate. When the agent cannot afford a specific question, or method of enquiry, because she cannot describe what she does not know – which is indeed unaffordable for her – it becomes necessary to perform a creative *context-shift* (Maeno & Ohsawa, 2007) and the almost serendipitous creation of an alternative pattern. Thus, enquiring within the second type of ignorance opens the possibility to discover a whole "cluster" of dark events, leading to a multiplicity of new chances. Abduction also provides an enhancement of the agent's perspective and knowledge but, in this case, the outcome is more of a gamble than the one previously described. Indeed, the required effort is more significant, and the opening of a new area of knowledge means also to take the risk to push the lucks into a complete useless direction.

To make an example of this chance discovery process too, we can refer to the recent invention of the Google Glasses. The problem was very challenging: the engineers wanted to create a new generation of devices moving away from the concept of the already existent computers and portable devices, such as tablets and smartphones. They had a problem that rose in a cognitive zone that was very peripheral for their expertise system: they were skilled at improving their operating system and updating the Google tools, but how to find and develop something utterly new? The story has it that Google X (the facility that is also realizing the project of driverless cars) readapted a project born for military use in 1995, and began to develop the "head-mounted display," trying to make it available to civilian purposes (Houston, 2012). Instead of selecting one of the already available options among their products, they created a radically new one, answering a problem with a brand new answer. From a very narrow knowledge, they stretched the research field and found out that it was literally a new ground full of chances to be picked up and to be offered to consumers: they had (almost) managed to make the prototype affordable and appealing to mass consumership thanks to the connection with social networking websites, Google maps, and so on. Plus, Google entered partnerships with eyewear companies to offer variable design to the product.

Obviously, with this choice both the risk and the opportunity at stake are high. But the opening of a new field of research and development is already a possibility toward compensating errors, misevaluations, or to further improve the most promising components. In its essence, the choice to discover a dark event through an ignorance-based chance discovery can be – in extreme cases – the invention of an incredibly resourceful treasure, or the opening of Pandora's box.

Conclusion

In conclusion, the two ignorance-based chance-discovery methods we presented assure the ability to discover new chances and increase the knowledge of the human agent. The first type is a specification of a well-known area: it can be helped with computational tools and it requires just the effort to investigate again a supposedly complete field. At the same time its outcome is often reliable but limited. On the contrary, the second method is more problematic and risky: it is a human prerogative and can be seen as an increase of the whole knowledge field of the agent. At the same time the outcome can be a big opportunity or a serious risk. In all of these cases, the range of the enquiry is determined by the dimension and deepness of the agent's ignorance: only with this *awareness* the chance-discovery process can be allowed to bring serious results to the chance research.

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