The Doomsday Argument and Hempel's Problem

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I Hempel's Problem

Hempel's Problem (thereafter, HP) is based on the fact that the two following assertions:

(H) All ravens are black
(H') Everything that is non-black is a non-raven

are logically equivalent. The logical structure of (H) is:

(H1) All X are Y

that is to say $\forall x\ (Xx \wedge Yx)$, whereas that of (H') has the form:

(H1') All non-Y are non-X

that is to say $\forall x\ (\sim Yx \wedge \sim Xx)$. In fact, the structure of the contrapositive form (H1') is clearly equivalent to that of (H1). It follows that the discovery of a black raven confirms (H) and also (H'), but also that the discovery of a non-black thing which is not a raven such as a pink flame or even a grey umbrella, confirms (H') and thus (H). This last conclusion appears paradoxical. The propositions (H1) and (H1') are based on four properties X, ~X, Y and ~Y, respectively corresponding to *raven*, *non-raven*, *black*, and *non-black* in the original version of HP. These four properties determine four categories of objects: XY, X~Y, ~XY and ~X~Y, which correspond respectively to *black ravens*, *non-black ravens*, *black non-ravens* and *non-black non-ravens*. One can observe here that a raven is defined with precision in the taxonomy within which it fits. A category as that of the ravens can be regarded as well defined, because it is based on a set of precise criteria defining unambiguously the species *corvus corax* and allowing the identification of its instances. It also appears that one can build without difficulty a version of HP where a variation with regard to the X class is operated. If one replace the X class with that of the tulips or that of the dolphins, etc. by adapting correlatively the Y property, one still obtains a valid version of HP. It appears thus that changes can be operated at the level of the X class without loosing the problem inherent to HP.

Similarly, the *black* property can be specified with precision, on the basis of a taxonomy of colours established with regard to the wavelengths of the light.[1] Moreover, one can consider variations with regard to the Y property. One will thus be able to choose properties such as *whose length is smaller than 50 cm*, *living less than 10 years*, etc. Such variations also lead to acceptable versions of HP. Lastly, it should be noted that the *non-black* property can be the subject of a definition which does not suffer from ambiguity, in particular with the help of the precise taxonomy of colours which has been just mentioned. Similarly, if one takes into account variations of the Y property such as *smaller than 40 cm*, or *whose diameter is larger than 25 cm*, etc, one arrives to definitions of the non-Y property which just as *non-black* are established with precision and lead in addition to versions of HP presenting the same problem as the original version. Thus, the X class, just as the properties Y and non-Y can be the subject of a precise and nonambiguous definition. Moreover, variations operated at the level of these classes lead to acceptable versions of HP. In contrast, the situation is not the same for the non-X class.

II The reference class Z

The concept of *non-raven* present in the original version of HP leads to highlight an important problem. What constitutes an instance of a *non-raven*? Intuitively a blue jay, a pink flame, a grey umbrella and even a natural integer constitute non-ravens. One is thus confronted with the definition of a new reference class - call it Z - including X and non-X. The Z class allows defining complementarily the class of non-X, and in the original version of Hempel, the class of *non-ravens*. Thus Z is the implicit reference class with regard to which the definition of the X class allows that of

[1] It is known that a monochromatic light, of single wavelength, meets practically only in laboratory. But the natural colours can be modelled in terms of subtraction of lights of certain wavelengths, starting from the white light of the Sun.

non-X. Does one have then to consider a Z class that goes until including abstract objects? Is it necessary to consider a concept of non-raven including abstract entities such as natural integers and complex numbers? Or is it necessary to limit oneself to a Z class, which only embraces concrete things? Such a discussion has its importance, because there are infinitely many abstract objects, whereas there are only finitely many individualised concrete objects. This fact is likely to influence later importantly the possible application of a bayesian reasoning. One could thus have a reference class Z including at the same time abstract objects (natural integers, real and complex numbers, etc.) and concrete objects such as artefacts but also natural entities such as humans, animals, plants, meteorites, stars, etc. Such a reference class is defined very extensively. And the consequence of such a choice is that the discovery of any object confirms (H') and thus (H). At this stage, anything[2] confirms (H). It should be noted that one can also have a definition of Z including all concrete objects that have been just mentioned, but excluding this time the abstract objects.

The instances of this class are now finitely denumerable, just as the cardinal of the corresponding set: the reference class Z then includes animals, plants, stars, etc. But alternatively, one could still consider a Z class associating the ravens (*corvus corax*) and the Audouin's gulls[3] (*larus audouinii*). In this case, the instances of the X class (*corvus corax*) are in a number larger than those of the non-X class (*larus audouinii*). And we always face the corresponding version of HP.[4]

Lastly, nothing seems to prohibit, at a very restrictive level, to choose a Z class made up of the X class, only added with one single element such as a red tulip. With this definition of Z, we still face a minimal version of HP. Of course, any object, added to the class of X and constituting the non-X class will be appropriate and then confirm at the same time (H') and (H). Thus, any object ~X~Y will lead to confirm (H). The remarks which have just been made call however an immediate objection. With various degrees, it is allowed to think that the choice of each reference class Z that has been just mentioned is arbitrary. Because it is allowed to reject on those grounds extreme definitions of Z such as the one defined above and including all abstract objects. Similarly, a Z class including the natural integers or the complex numbers can also be eliminated. The X class is defined with regard to the concrete objects that are the ravens and there is not particular reason to choose a Z class including abstract entities.

Similarly, one will be able to reject a definition of Z based on a purely artificial restriction, simply associating with X a determinate object such as a red tulip. Because I can choose arbitrarily, the object that constitutes the complement of X, i.e. I can define Z as I wish. Such an extreme conception appears as without relationship with the initial definition of X. A Z class thus defined is not homogeneous. And there is no justification to legitimate the association of a red tulip to the class of the ravens to build that of Z. The association within a same Z class of the ravens and the Audouin's gulls, appears analogously as an illegitimate choice. Why not then the association of the ravens and the goldfinches? Such associations are symptomatic of a purely artificial selection. Thus, the choices of reference classes Z mentioned above reveal an arbitrary and artificial nature. Indeed, shouldn't one make one's possible to find a Z class which is the most natural and the most homogeneous possible, taking into account the given definition of X? One can think that one must attempt to operate a determination of the Z class, which is the most objective possible. In the original version of HP, doesn't the choice of the ravens for the X class implicitly determine a Z class which is directly in connection with that of the ravens? A Z class naturally including that of the ravens such as that of the corvidae, or that of the birds, seems a good candidate. Because such a class is at least implicitly determined by the contents of the X class. But before analysing versions of HP built accordingly, it is worth considering before some nonparadoxical versions of HP.

III The analogy with the urn

It is notoriously admitted that certain versions[5] of HP are not paradoxical. Such is in particular the case if one considers a reference class Z associated with boxes, or a set of playing cards. One can also consider a version of HP associated with an urn. An X class is thus considered where the objects are finitely denumerable and which only includes balls and tetrahedrons. The Y class itself is reduced to two colours: red and green. One has thus four types of objects: *red balls*, *green balls*, *red tetrahedrons* and *green tetrahedrons*. In this context, we have the following version of HP:

(H2) All balls are red
(H2') All non-red objects are non-balls

It appears here that the case of red tetrahedrons can be ignored. Indeed, their role is indifferent and one can thus ignore their presence in the urn. They can be regarded as parasitic objects, whose eventual presence in the urn does not have importance. One is thus brought to take into account an urn containing the significant objects consisting in red balls,

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[2] Any object ~X~Y in the Z class thus extensively defined.

[3] The total population of Audouin's gulls is evaluated with approximately 3000 couples (cf. Thibault 1983, 132).

[4] This incidentally makes it possible to verify that HP does not find its origin in a disproportion of the X class compared to that of the non-X. The fact that the instances of the X class are in a number larger than those of the non-X does not prevent the emergence of a version of HP.

[5] Properly speaking, these are not thus versions of HP, since they are nonparadoxical. But the corresponding propositions have the logical structure of (H) and (H').

green balls and green tetrahedrons. And the fact that non-red objects can only be green, and that non-balls can only be tetrahedrons leads to consider equivalently:

(H3) All balls are red
(H3') All green objects are tetrahedrons

that clearly constitutes a nonparadoxical version of HP. Indeed, the draw of a red ball confirms (H3) and (H3') whereas the draw of a green tetrahedron confirms (H3') and (H3).

Consider now the case where the urn contains six significant objects.[6] One has just drawn three red balls and one green tetrahedron (the draw is 3-0-1[7]) and one makes then the hypothesis (H3). At this stage, the probability that all balls are red corresponds to three draws (3-0-3, 4-0-2 and 5-0-1) among six possible draws (3-0-3, 3-1-2, 3-2-1, 4-0-2, 4-1-1, 5-0-1). Similarly, the probability that all green objects are tetrahedrons is identical. Thus, P(H3) = P(H3') = 1/2 and also P(~H3) = P(~H3') = 1/2. These initial probabilities being stated, consider now the case where one has just carried out a new draw in the urn. Another red ball is drawn (the draw is 4-0-1). This corresponds to three possible compositions of the urn (4-0-2, 4-1-1, 5-0-1). Let E be the event consisting in the draw of a red ball in the urn. We have then the probability of drawing a red ball if all the balls of the urn are red, i.e. P(E, H3) such as P(E, H3) = 2/3, since two cases (4-0-2, 5-0-1) correspond to the fact that all balls are red. In the same way, P(E, ~H3) = 1/3. The situation is identical if one considers P(E, H3') and P(E, ~H3'). One is then in a position to calculate the posterior probability that all balls are red using Bayes formula: P'(H3) = [P(H3) X P(E, H3)] / [P(H3) X P(E, H3) + P(~H3) X P(E, ~H3)] = (0,5 X 2/3) / (0,5 X 2/3 + 0,5 X 1/3) = 2/3. And P'(~H3) = 1/3. There are identical results concerning P'(H3') and P'(~H3'). Thus, P'(H3) > P(H3) and P'(H3') > P(H3'), so that the hypothesis (H3) just as the equivalent hypothesis (H3') are confirmed by the draw of a new red ball.

Let us examine finally the situation where, instead of a red ball, one draws a green tetrahedron (the draw is 3-0-2) in the urn. Let thus F be the event consisting in the draw of a green tetrahedron. In this case, we have three possible combinations (3-0-3, 3-1-2, 4-0-2). But among these, two (3-0-3, 4-0-2) correspond to a situation where hypotheses (H3) and (H3') are confirmed. Thus, P(F, H3) = P(F, H3') = 2/3 and P(F, ~H3) = P(F, ~H3') = 1/3. A bayesian calculation provides the same results as on the preceding hypothesis of the draw of a red ball. Thus, on the hypothesis of the draw of a green tetrahedron, one calculates the posterior probabilities P'(H3) = P'(H3') = 2/3 and P'(~H3) = P'(~H3') = 1/3. Thus, the draw of a green tetrahedron confirms at the same time (H3') and (H3). It should be noted that one can easily build versions of HP allowing to establish nonparadoxically the preceding reasoning. Consider a cubic mineral block of 1m on side. Such an object of $1m^3$ is divided into 1000 cubic blocks of 1 dm^3, consisting either of quartz, or of white feldspar. One examines fifty of these blocks, and one notes that several of them consist of white feldspar of gemmeous quality. One is brought to make the hypothesis that all blocks of white feldspar are of gemmeous quality. We have then the following version of HP:

(H4) All blocks of white feldspar are of gemmeous quality
(H4') All blocks of non-gemmeous quality are not white feldspar

that is equivalent to:

(H5) All blocks of white feldspar are of gemmeous quality
(H5') All blocks of non-gemmeous quality are quartz

where we have in effect the equivalence between (H5) and (H5') and where a correct bayesian reasoning can be established. Such an example (call it the *mineral urn*) can also be transposed to other properties X and Y, since identical conditions are preserved.

IV A solution to the problem

One must, taking into account the above developments,[8] attempt to highlight a definition of the Z class that does not present an arbitrary and artificial nature, but proves on the contrary the most natural and the most homogeneous possible, with regard to the given definition of X. Consider accordingly the following[9] version of HP:

(H6) All Corsican-Sardinian goshawks have a wingspan smaller than 3,50 m
(H6') All birds having a wingspan larger than 3,50 m are not Corsican-Sardinian goshawks

6 The red tetrahedrons possibly found in the urn are regarded as nonsignificant objects.

7 With the notation: *n-p-q* (red balls - green balls - green tetrahedrons).

8 Cf. § II.

9 This particular version of HP is chosen here because it is based on an X class corresponding to the subspecies *accipiter gentilis arrigonii*. Conversely, the original version of HP is grounded on the species *corvus corax*. The choice of a subspecies for the X class allows simply here a supplementary level of integration.

In this particular version of (H'), the X class is that of the Corsican-Sardinian goshawks,[10] and the reference class Z is that of the birds. This last class presents an obvious relationship with that of the Corsican-Sardinian goshawks. It is allowed to think that such a way of defining Z with regard to X is a natural one. Indeed such a definition does not present an arbitrary nature as obviously as that was the case with the examples of Z classes mentioned above. Of course, one can observe that it is possible to choose, in a more restricted but so natural way, a Z class corresponding to the *accipiter* genus. Such a class presents a homogeneous nature. It includes in particular the species *accipiter gentilis* (northern goshawk) but also *accipiter nisus* (European sparrowhawk), *accipiter novaehollandiae* (grey goshawk), *accipiter melanoleucus* (black and white goshawk).

However, alternatively and according to the same viewpoint, one could also extend the Z class to the instances of the - wider - family of accipitridae[11] including at the same time the *accipiter* genus which have been just mentioned, but also the *milvus* (kite), *buteo* (buzzard), *aquila* (eagle), etc. genus. Such a class includes in particular the species *milvus migrans* (black kite), *milvus milvus* (red kite), *buteo buteo* (common buzzard), *aquila chrysaetos* (golden eagle), etc. These various acceptable definitions of the Z class find their justification in the taxonomy within which the Corsican-Sardinian goshawk inserts itself. More systematically, the latter belongs to the subspecies *accipiter gentilis arrigonii*, to the species *accipiter gentilis*, to the *accipiter* genus, to the family of *accipitridae*, to the order of *falconiformes*, to the class of *birds*, to the subphylum of *vertebrates*, to the phylum of *chordates*,[12] to the *animal* reign, etc. It ensues that the following variations of (H') are acceptable, in the context which has just been defined:

(H7') All northern goshawks having a wingspan larger than 3,50 m are not Corsican-Sardinian goshawks
(H8') All goshawks having a wingspan larger than 3,50 m are not Corsican-Sardinian goshawks
(H9') All accipitridae having a wingspan larger than 3,50 m are not Corsican-Sardinian goshawks
(H10') All falconiformes having a wingspan larger than 3,50 m are not Corsican-Sardinian goshawks
(H11') All birds having a wingspan larger than 3,50 m are not Corsican-Sardinian goshawks
(H12') All vertebrates having a wingspan larger than 3,50 m are not Corsican-Sardinian goshawks
(H13') All chordates having a wingspan larger than 3,50 m are not Corsican-Sardinian goshawks
(H14') All animals having a wingspan larger than 3,50 m are not Corsican-Sardinian goshawks

There are thus several versions of (H') corresponding to variations of the Z class which themselves are made possible by the fact that the Corsican-Sardinian goshawk belongs to *n* categories, determined by the taxonomy to which it belongs. And in fact, when I meet one northern goshawk belonging to the nominal form (*accipiter gentilis gentilis*), it is at the same time a northern goshawk (*accipiter gentilis*) non- Corsican-Sardinian (non-accipiter gentilis arrigonii), a goshawk (*accipiter*) non-Corsican-Sardinian goshawk, an accipitridae non-Corsican-Sardinian goshawk, a falconiformes non-Corsican-Sardinian goshawk, a bird (*aves*) non-Corsican-Sardinian goshawk, but also a vertebrate non-Corsican-Sardinian goshawk, a chordate non-Corsican-Sardinian goshawk, an animal non-Corsican-Sardinian goshawk. Thus, the instance of *accipiter gentilis gentilis* that I have just observed, belongs at the same time to all these categories. And when I meet a grey whale, it is not a bird non-Corsican-Sardinian goshawk, but it is indeed a vertebrate non-Corsican-Sardinian goshawk, as well as a chordate non-Corsican-Sardinian goshawk, and also an animal non-Corsican-Sardinian goshawk.

In general, a given object *x* which has just been discovered belongs to *n* levels in the taxonomy within which it fits. It belongs thus to a subspecies, [13] a species, a sub-genus, a genus, a super-genus, a subfamily, a family, a super-family, a subphylum, a junction, a reign... One can assign to the subspecies the level[14] 1 in the taxonomy, to the species the level 2..., to the super-family the level 8, etc. And if within (H), the class X is at a level *p*, it is clear that Z must be placed at a level *q* such as $q > p$. But how to fix Z at a level *q* which is not arbitrary? Because the reference class Z corresponds to a level of integration. But where must one stop? Does one have to attach Z to the level of the species, the sub-genus, the genus..., the reign? One does not have an objective criterion allowing the choice of a level *q* among the possibilities that are offered. I can choose *q* close to *p* by proceeding by restriction; but in a so conclusive way, I am authorised to choose *q* distant from *p*, by applying a principle of extension. Then why choose such class of reference restrictively defined

[10] The Corsican-Sardinian goshawks (*accipiter gentilis arrigonii*) constitute a subspecies of the northern goshawk, specific to Corsica and Sardinia. This endemic subspecies differs from the nominal form of the northern goshawk by the following characteristics (cf. Thibault 1983): the colouring of the head is blackish instead of brown blackish; the back is brown; the lower part is darker.

[11] The ornithologists still distinguish the class of the accipitriformes, corresponding to all accipitridae, to which are added the pandlionidae, such as *pandlion haliaetus* (osprey), etc.

[12] The phylum of *chordata* includes all vertebrates and some invertebrates, which present the property of having a dorsal chord, at least at a given period of their life.

[13] It is possible to consider alternatively, if one wishes, another taxonomy that our current scientific taxonomy. That does not affect the current reasoning, since the conclusions are identical, since the principles of classification are respected.

[14] It is obviously possible to take into account finer taxonomies and including additional subdivisions starting from the various subspecies. Obviously, that does not affect the current line of reasoning.

rather than such other extensively defined? One does not have actually a criterion to legitimate the choice, according to whether one proceeds by restriction or by extension, of the Z class. Consequently, it appears that the latter can only be defined *arbitrarily*. And it follows clearly here that the determination of the Z class and thus of the non-X class is arbitrary. But the choice of the reference class Z appears fundamental. Because according to whether I choose such or such reference class Z, it will result from it that a given object *x* will confirm or not (H). For any object *x*, I can build a Z class such as *x* belongs to non-X, as I can choose a Z class such as *x* does not belong to non-X. Thus, this choice is left to my arbitrary.

For a given object *x*, I can build a Z class such as this object confirms (H) and another Z class such as this object does not confirm (H). Of course, if Z is selected arbitrarily, the bayesian reasoning inherent to HP "works", but corresponds to an arbitrary and artificial point of view: having found an object *x*, (H) is confirmed. But one can as well choose, in a so artificial and more restrictive way, a Z class where *x* misses and where *x* does not confirm (H). Thus, one is not enabled to conclude objectively that the discovery of the object *x* confirms (H). Because to reason thus would amount to conferring a universal and general value to a viewpoint which is only the expression of an arbitrary choice.

How this result can be reconciled with the facts mentioned above,[15] concerning the existence of nonparadoxical versions of HP? It is worth noting here that the bayesian reasoning can be established in each case where the Z class is finite, and where this fact is known before the experiment.[16] One can then show a bayesian shift. But at this stage, it is worth distinguishing the cases where the Z class is determined before the experiment by an objective criterion and the cases where it is not the case. In the first case, the contents of the Z class are given before the experiment and the Z class is thus not selected arbitrarily, but according to an objective criterion. Consequently, the bayesian reasoning is correct and provides relevant information. Such is in particular the case when one considers a version of HP applied to an urn, or a version such as the *mineral urn*. On this last hypothesis, the composition of the Z class is fixed in advance. There is then a significant difference with Nicod's criterion:[17] an object ~X~Y confirms (H) and an object XY confirms (H').

Conversely, when the Z class is not fixed and is not determined before the experiment by an objective criterion, one can subjectively choose Z at any level of extension or restriction, but the conclusions resulting from the bayesian reasoning must be regarded as purely arbitrary and do not present thus an objective value. Because one then does not have a base and a justification to choose such or such level of restriction or extension. Thus, in this case, Nicod's criterion according to which any object ~X~Y is neutral with respect to (H) and any object XY is neutral with respect to (H'), can apply itself. It should be observed that the present solution has the effect of preserving the equivalence of a proposition and its contraposition. And similarly, the principle of the confirmation of a generalisation by each of its instances is also preserved.

V A common solution to Hempel's Problem and the Doomsday Argument

The Doomsday Argument (thereafter, DA) attributed to Brandon Carter, has been described by John Leslie (1992).[18] DA can be described as follows. Consider an event A: the final extinction of the human race will occur before year 2150. One can estimate at 1 chance from 100 the probability that this extinction occurs: P(A) = 0,01. Let also ~A be the event: the final extinction of the human race will not occur before 2150. Consider also the event E: I live during the 1990s. In addition one can estimate today at 50 billions the number of humans having existed since the birth of humanity: let H_{1997} be such a number. In the same way, the current population can be evaluated to 5 billions: $P_{1997} = 5x10^9$. One calculates thus that one human from ten, if event A occurs, will have known the 1990s. The probability that humanity is extinct before 2150 if I have known the 1990s, is thus evaluated: $P(E, A) = 5x10^9/5x10^{10} = 0,1$. On the other hand, if the human race passes the course of the 2150s, one can think that it will be destined to a much more significant expansion, and that the number of humans will be able to rise for example to $5x10^{12}$. In this case, the probability that the human race is not extinct after 2150 if I have known the 1990s, can be evaluated as follows: $P(E, \sim A) = 5x10^9/5x10^{12} = 0,001$. This now makes it possible to calculate the posterior probability of the human race extinction before 2150, using Bayes formula: $P'(A) = [P(A) \times P(E, A)] / [P(A) \times P(E, A) + P(\sim A) X P(E, \sim A)] = (0,01 \times 0,1) / (0,01 \times 0,1 + 0,99 \times 0,001) \approx 0,5025$. Thus, the fact of taking into account the fact that I live currently has made the probability of the human race extinction before 2150 shift from 0,01 to 50,25.

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15 Cf. § III.

16 As we have seen, the bayesian reasoning cannot take place when one considers a Z class including infinite sets such as natural integers, real numbers, etc.

17 Nicod's criterion is defined as follows (Hempel 1945, 11), with S1 = (H) and S2 = (H'): '(...) let has, B, C, D Be furnace objects such that has is has raven and black, B is has raven goal not black, C not has raven goal black and D neither has raven NOR black. Then, according to Nicod' S criterion, has would confirm S1, goal Be neutral with respect to S2; B would disconfirm both S1 and S2; C would Be neutral with respect to both S1 and S2, and D would confirm S1, goal Be neutral with respect to S2.'

18 John Leslie, 'Time and the Anthropic Principle.' *Mind*, **101** (1992): 521-40.

I have presented in my paper 'Une Solution pour l'Argument de l'Apocalypse'[19] a solution to DA, whose main lines can be described as follows. The DA reasoning is based on a single reference class, which is that of the *humans*.[20] But how this reference class has to be defined? Should it be limited to the only representatives of our current subspecies *Homo sapiens sapiens*? Or does one have to extend it to all the representatives of the species *Homo sapiens*, by including this time, in addition to *Homo sapiens sapiens*, *Homo sapiens neandertalensis*...? Or is it necessary to include in the reference class the entire *Homo* genus, including then all the successive representatives of *Homo erectus*, *Homo habilis*, *Homo sapiens*, etc? And isn't it still necessary to go until envisaging a wider class, including all the representatives of a super-genus S, made up not only of the *Homo* genus, but also of the new genus *Surhomo*, *Hyperhomo*, etc. which will result from the foreseeable evolutions from our current species? It appears thus that one can consider a reduced reference class by proceeding by restriction, or apprehend a larger class by making the choice of a reference class by extension. One can thus operate for the choice of the reference class by applying either a principle of restriction or a principle of extension. And according to whether one applies one or the other principle, various levels of choice are each time possible.

But it appears that one does not have an objective criterion, which makes it possible to legitimate the choice of such or such a reference class. And even our current subspecies *Homo sapiens sapiens* cannot be regarded as a natural and an adequate choice for the reference class. Because isn't it allowed to think that our paradigmatic concept of *human* has to undergo evolutions? And in addition, the fact of excluding from the reference class a subspecies such as *Homo sapiens neandertalensis* or the future evolutions of our species, doesn't it reveal an anthropocentric viewpoint? Since one does not have an objective selection criterion, one can choose arbitrarily one or the other of the classes that have been just described. One can for example identify the reference class to the species *Homo sapiens*, and observe a bayesian shift. There is indeed then an increase in the posterior probability of the extinction of *Homo sapiens*. But this bayesian shift is worth as well for a still more restricted reference class, such as our subspecies *Homo sapiens sapiens*. There too, the application of Bayes formula leads to an appreciable increase in the posterior probability of the nearest end of *Homo sapiens sapiens*. However identically, the bayesian shift also applies to a still more reduced reference class, which is that of the representatives of *Homo sapiens sapiens having not known the computer*. Such a reference class will certainly face a nearest extinction. There however, such a conclusion is not likely to frighten us, because the evolutionary potentialities of our species are such that the succession of a new species to those which preceded them, constitutes one of the characteristics of our evolution mode.

It should be mentioned that this solution leads here to accept the conclusion (the bayesian shift) of Carter and Leslie for a given reference class, while placing it in comparison with conclusions of comparable nature relating to other reference classes, completely inoffensive. The fact of taking into account various levels of restriction, made legitimate by the lack of an objective criterion of choice, leads finally to the harmlessness of the argument. Thus, it appears that the argument based on the reference class and its arbitrary choice by restriction or extension constitutes a common solution to HP and DA. HP and DA are ultimately underlain by the same problem inherent to the definition of the Z class of HP and the single reference class of DA. One thus has a solution of comparable nature for the two paradoxes. It is worth here concluding by presenting an element that tends to confirm the common source of the two problems. One will observe first that one is not able to highlight a version of DA corresponding veritably to the original version of HP, a reference class such as that of the ravens being not transposable in DA. The inherent argument in DA is indeed based on the use of the anthropic principle and requires obviously a reference class made up of intelligent beings. When Leslie[21] considers the extension of the reference class, he specifies expressly that the condition for the membership of the reference class is the aptitude to produce an anthropic reasoning. On the other hand it is possible to describe a version of HP made up from the elements of DA. If one takes X for our current subspecies *Homo sapiens sapiens* and Y for *are alive only before 2150*, one obtains the following version of HP:

(H15) All Homo sapiens sapiens will be alive only before the year 2150
(H15') All those which will live after 2150 will be non-Homo sapiens sapiens

In this context, an alive human being in 1997 constitutes an instance confirming (H15). In parallel, the discovery of an *Homo sapiens sapiens* after 2150 leads to refute (H15). Lastly, the discovery of an alive non-Homo sapiens sapiens after 2150 constitutes a confirmation of (H15') and thus of (H15). Taking into account this particular formulation, it is clear that one currently only observes instances confirming (H15). On the other hand, after 2150, one will be able to have instances refuting (H15) or instances confirming (H15').

It is worth noting here that (H15) does not allow veritably to be used as support of a version of DA. Indeed, the reference class identifies itself here precisely as *Homo sapiens sapiens*, whereas in the original version of DA, the

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[19] *Canadian Journal of Philosophy* **28** (1998) 227-46.

[20] Leslie uses the terms of *human race*.

[21] 'How much widening of the reference class is appropriate when we look towards the future? There are strong grounds for widening it to include our evolutionarily much-altered descendants, three-armed or otherwise, as 'humans' for doomsday argument purposes - granted, that's to say, that their intelligence would remain well above the chimpanzee level.' (1996, 262)

reference class consists in the *human race*. Consequently, one has not, strictly speaking, an identity between the event underlie by (H15) and A, so that (H15)-(H15') does not constitute a joint version[22] of DA and HP.

But this version of HP being made up with the elements of DA, one must be able, at this stage, to verify the common origin of the two problem, by showing how the argument raised in defence of DA with regard to the reference class, can also be used in support of HP. One knows the response made by Leslie to the objection that the reference class for DA is ambiguous or, due to the evolutions of *Homo sapiens sapiens*, leads to a heterogeneous reference class, of composite nature. It is exposed in the response made to Eckhardt:

> How far should the reference class extend? (...) One can place the boundary more or less where one pleases, provided that one adjusts one's prior probability accordingly. Exclude, if you really want to, all future beings with intelligence quotients above five thousand, calling them demi-gods and not humans[23].

and developed in *The End of the World*[24]:

> The moral could seem to be that one's reference class might be made more or less what one liked. (...) What if we wanted to count our much-modified descendants, perhaps with three arms or with godlike intelligence, as 'genuinely human'? There would be nothing wrong in this. Yet if we were instead interested in the future only of two-armed humans, or of humans with intelligence much like that of humans today, then there would be nothing wrong in refusing to count any others[25].

For Leslie, one can go until including in the reference class, the descendants of humanity become very distant from our current species due to the fact of evolution. But Leslie also accepts liberally that one limits the reference class to the only individuals close to our current humanity. One is thus free to choose the reference class that one wishes, while operating either by extension, or by restriction. It will be enough in each case to adjust the initial probability accordingly. It appears here that this type of answer can be transposed, literally, to an objection to HP of comparable nature, based on the reference class of (H15)-(H15'). One can fix, so the objection goes, the Z class as one wishes, and assign to "all those" the desired content. One can for example limit Z to the species *Homo sapiens*, or well associate it to the whole of the *Homo* genus, including then the evolutions of our species such as *Homo spatialis*, *Homo computeris*, etc. What is important - could continue this defender - is to determine preliminarily the reference class and to conserve this definition when the various instances are then met. Thus, it proves that the arguments advanced in support of the reference class of DA can be transposed in defence of HP. This constitutes an additional element, going in the direction of the common origin of the two problems, dependent on the definition of a reference class. DA and HP need consequently a same type of answer. Thus, the urn of Carter and Leslie flows in that of Hempel.[26]

References

ECKHARDT, W. 1993. "Probability Theory and the Doomsday Argument." *Mind*, 102 (1993): 483-8

FRANCESCHI, P. 1998, "Une Solution pour l'Argument de l'Apocalypse." *Canadian Journal of Philosophy*, 28 (1998): 227-46

GOODMAN, N. 1955. *Fact, Fiction and Forecast.* Cambridge: Harvard University Press.

HEMPEL, C. 1945. "Studies in the logic of confirmation." *Mind*, 54 (1945): 1-26 et 97-121

LESLIE, J. 1992. "Time and the Anthropic Principle." *Mind*, 101 (1992): 521-40

---. 1993. "Doom and probabilities." *Mind*, 102 (1993): 489-91

---. 1996. *The End of the World: the science and ethics of human extinction.* London and New York: Routledge.

PAPINEAU, D. 1995. "Methodology: the Elements of the Philosophy of Science." In *Philosophy A Guide Through the Subject*, ed. A.C. Grayling. Oxford: Oxford University Press.

SAINSBURY, M. 1988. *Paradoxes.* New York: Cambridge University Press.

THIBAULT, J-C. 1983. *Les oiseaux de Corse.* Paris: De Gerfau.

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22 I.e. comprising simultaneously the two problems.

23 W. Eckhardt, 'Probability Theory and the Doomsday Argument.' *Mind*, **102** (1993): 483-8; cf. John Leslie, 'Doom and probabilities.' *Mind*, **102** (1993): 489-91

24 This point of view is detailed by Leslie, in the part entitled 'Just who should count have being human?' (*The End of the World*, 256-63).

25 Cf. Leslie (1996, 260).

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