INFORMATION ETHICS AND ENTROPY

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Introduction

In response to what has been termed the foundational problem in computing ethics Luciano Floridi and Jeff Sanders (F&S) have developed Information Ethics (IE) (Floridi, 1999, 2002, Floridi and Sanders, 2001, 2002). *Prima facie* this new theory appears to offer some hope in providing a robust platform upon which moral issues involving ICT can be ethically analysed. Nevertheless the theory has proved controversial and is not without its critics. This paper identifies and explores what I consider to be a significant challenge for the theory. The problem relates to Floridi's use of the term *entropy* which is quite at odds with various other interpretations of the term. Floridi's conception of information entropy appears to be by and large the ethical equivalent of the uses of evil, pain and suffering in more orthodox ethical theories. Thus, informational entropy for Floridi is the loss, degradation, corruption or depletion of information objects. In this paper I shall argue that Floridi's use of the concept of entropy is somewhat confusing but more importantly sets up a troublesome paradox within his Information Ethics (IE). The paper outlines the problems before presenting a possible solution.

The paper shall proceed as follows. In section 1 ~~we briefly outline Information Ethics, its scope and aims~~[1]. In section 2 we turn to the issues with informational entropy

[1] Please note, this paper is a condensed version of a 12,000 word paper on this topic. As such I have left out all introductory material on Information Ethics and assume that the audience will have a basic understanding of Information Ethics, in particular the work of Floridi and Sanders.

which form the central part of this paper. We identify these issues and consider them in some detail. Section 3 looks at how the problems might be addressed.

Entropy

In order to clarify his particular conception of entropy Floridi offers an allegory, a boy smashing car windscreens in a dump yard. (See Floridi, 1999, p54).

For various reasons outlined in the 1999 paper Floridi dispenses with each of the more traditional approaches finally coming to Information Ethics. IE Floridi claims provides an ethical argument as to why the boy's behaviour is "a case of blameworthy vandalism" (*ibid*). The boy, Floridi claims "is not respecting the objects for what they are, and his game is only increasing the level of entropy in the dumping ground, pointlessly" (*ibid*). That is, under IE, even a dumped broken down old car deserves the right to flourish within the infosphere as an information object.

I do not find this argument entirely convincing, it is not immediately obvious that the boy's behaviour constitutes "blameworthy vandalism". IE just seems to be *telling* us it is wrong without really explaining why. It seems Floridi's claim approaches the level of question begging of which he accuses virtue ethics. Bynum following Wiener argues ever increasing entropy is "the great destroyer that eventually dismantles all patterns and structures" (in Van Den Hoven & Weckert 2008, pg 17). Thus entropy, operating in one temporal direction eventually dismantles all information objects. There are certainly other arguments that could be made to say why a boy ought not to smash the windows of a discarded car in a dump yard but these arguments seem to be related to the antisocial nature of the behaviour or the good character of the boy. The only thing I think we can blame the boy for is perhaps the acceleration of entropy.

Furthermore there is another argument that could be developed against the dump yard allegory. Floridi seems to confuse levels of abstraction with regard to entropy here. Certainly at an everyday LoA as well as a "thermodynamic LoA" to be sure the boy seems to be contributing to entropy (at least accelerating the process) within his surroundings. Entropy is unidirectional, the window can't be put back together again – and then Floridi argues, the boy is showing lack of consideration or care for his surroundings. However at an informational LoA in fact the boy is arguably increasing the informational complexity of his immediate surroundings. Each piece of broken glass for example surely from an informational LoA is individually as much a valued as informational entity in its own right as an intact windscreen is. I can only imagine appeals to anthropic levels of abstraction that

would value an intact windscreen over the thousands of beautiful, glittering, individual, unique packets of information that represent the shattered windscreen. We could argue informational entropy in this case does not appear to be being degraded or destroyed indeed we could argue the contrary is the case. It is certainly the case that entropy is increasing but the entropy in question is being caused at another LoA, one that views the degradation, decay and general increase in disorder of macroscopic objects as entropy but this seems to be the kind of entropy Floridi argues that informational entropy is not.

To understand this further we need to take a look at conceptions of entropy in general noting that Floridi's argues that his use of the term differs considerably from the typical physicist's conception forming a part of the second law of thermodynamics. The physicalist thermodynamic conception of entropy states that within any process in an isolated system, in relation to the physical systems potential for work entropy always increases. Entropy runs in one direction and is generally irreversible – we cannot put back together the shattered windscreen.

There are biological construals of entropy related to thermodynamic entropy. Schrodinger's early biological discussions involving entropy are interesting. In his 1944 text *What is Life?* he suggests that organisms avoid decay and disorder by consuming, eating, drinking and breathing, or assimilating in the case of plants. Lehninger a biochemist, following Schrodinger observed the apparent order in cellular organisms and argued that as cells grow and divide the order is compensated for by the corresponding "disorder" they generate within their environment, thus "organisms preserve their internal order by taking from their surroundings free energy, in the form of nutrients or sunlight, and returning to their surroundings an equal amount of energy as heat and entropy." (1993). Clearly the imposition of order is at the corresponding cost of disorder somewhere else. Recently Kaila and Annila (2008) describe evolution in terms of an exchange of energy or a dispersion of energy, and a corresponding increase in entropy towards a stationary state, that is, energy tends to flow toward a state of equilibrium, in the absence of a high freely available energy source. Natural selection, they go on to argue tends to favour adaptations that lead to faster entropy increases, equivalent to an increased depletion in freely available energy, within the ecosystem.

It is important to note here that clear connections are evident between construals of entropy analysed at a materialist or physicalist LoA with those at a biological and chemical LoA. There is a general movement towards states of equilibrium at the cost of an increase in entropy elsewhere in the system. Entropy is construed as a part of the natural order of

things. From a biological perspective entropy is the trade off for life and order. Organisms that flourish do so at the expense of faster and higher increases in entropy in the surrounding environment as they consume available energy. Floridi however wants to paint informational entropy in a slightly different light. It seems reasonable to me that we should expect to find connections between materialist, chemical or scientific construals of entropy and informational entropy.

Floridi's IE does admit an inverted relation between informational complexity and entropy with regard to exchange of semantic value but there is no acknowledgement of an entropy cost associated with increasing semantic complexity in information objects elsewhere in the infosphere. Floridi explains it like this, "as the infosphere becomes increasingly meaningful and rich in content, the amount of information increases and the amount of entropy decreases, or as entities wear out, the amount of entropy increases and the amount of information decreases." (Floridi, 1999, p44). In a later article Floridi explains entropy as any form of destruction or corruption of informational objects, or "any form of impoverishment of being" (Floridi, 2010, pg 84). Since every extant object or state of affairs[2] qualifies as an informational object any destruction or corruption of anything at all contributes to entropy and supposedly a corresponding decrease in information.

This seems odd to me. It seems Floridi does not want to attribute any cost associated with increased levels of semantic complexity within the infosphere. We could call this the free lunch argument. All forms of structure and order come at some cost. This applies equally to semantic informational structures. For example, the information conveyed by the rings which form on a tree trunk with the passing of each season come at the expense of that tree taking nutrients from the soil, water, air (carbon dioxide, hydrogen and oxygen) and using sunlight to convert this material into organic material, this process directly contributes to the information conveyed by tree rings.

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[2] David Armstrong has developed a comprehensive metaphysical theory of the world consisting of "states of affairs". Armstrong's view is that a state of affairs is the instantiation of a particular property or set of properties in objects. This view is not altogether different to Floridi's informational realism in that the Aristotelian "substance", or Floridi's entity or object is to a large extent unknowable, instead what we can talk about is the information, or what Armstrong would call attributes or universals. In chapter 3 of this work I argue that "states of affairs" constitute finite discrete informational entities in their own right. By extending informational realism in such a way we also accommodate causal processes interpreted at an Informational LoA as legitimate informational entities and thus exposed them to the same ethical scrutiny under IE.

If we construe structured meaningful information as the opposite to entropy, correspondingly this information is representative of some form of physical order at an alternative LoA, this order (at the physical LoA) is at the expense of some increase in physical entropy somewhere else within the system (the infosphere) and correspondingly at the informational LoA some informational entropy has occurred to bring into being a complex informational entity. Just as evolution is a movement toward increased complexity in form, correspondingly at the informational LoA an increase in informational complexity or form is necessarily at the expense of an increase in entropy due to energy consumption somewhere else within the environment. This energy consumption can be represented in informational terms by the degradation or consumption (entropy) of the informational entities that are representative of nutrients, chemicals and so on required to sustain the order of the information object in question.

Informational Entropy – Ver 2.0

I propose a subtle change in the way we ought to interpret entropy within IE. Analogous to physical (thermodynamic) entropy which is the tendency toward heat/energy equilibrium, I believe information is conserved in a similar way. On this account informational entropy, similar to thermodynamic entropy is a uni-directional process from organised, structured complex informational entities and states of affairs to increasingly disordered or unstructured states of informationality but equally without loss, that is, information is conserved but transformed. Like thermodynamic entropy, informational entropy is in general a non-preventable process whereby the overall state of informational order in the infosphere is constantly moving towards less ordered states. The destruction of an object does not entail the complete loss or destruction of information rather a reorganisation of that information. Information generally becomes more distributed, and in some cases more complex[3] but rather than describing the process as a loss of information I think it is better described as information being transformed from one state to another. Informational entropy is thus a form of non-loss decomposition. As an information object is degraded, decomposes, is destroyed or corrupted information is transformed and moves towards less structured, more homogenous and austere informational states.

[3] However any increase in complexity will almost certainly come at a cost. That cost will be an increase in entropy somewhere else within the system.

Let's examine in more detail the idea of what Floridi might mean for the infosphere as a whole to become increasingly meaningful and rich in content. The infosphere includes individual informational entities, finite sets of related entities, or in Armstrong's (1998) terminology states of affairs, indeed all extant objects interpreted at an informational LoA. A fundamental problem is this: Virtually all human activity increases the level of entropy in the infosphere at some level of abstraction. This is supported by Kaila and Annila (2008), "The principle of increasing entropy, equivalent to the decreasing free energy, is pure and austere but its mechanical manifestations can be complex and intricate." (*ibid*). There is no free lunch. Our existence and more so our flourishing necessary entails an increase in entropy, indeed the more successful we are, the more semantically rich and complex the infosphere becomes the faster the rate by which entropy increases.

We can equally say that increased states of societal order and complexity resulting in increased informational complexity and semantic content require increased energy input – resulting necessarily in increased levels of entropy. Very simple societies utilise low levels of energy and are correspondingly represented with low degrees of individual specialisation and general complexity. (Tainter, 1990). Entropy seen at materialist LoA also has its analogy at an informational LoA. I consider informational entropy as not being the loss of information but instead the transformation of information from structured ordered states to increasingly disordered (but not random) homogenous states tending to what I will call informational equilibrium. The complete end-state of informational equilibrium is simply analogous to the physical thermodynamic equilibrium but interpreted at the informational LoA. If this is not the case then the onus is on the claimant to explain how entropy could be decreasing at one level of abstraction (the informational level) yet increasing at another (physical, chemical or biochemical levels).

Kaila and Annila offer further support for this thesis. "Thermodynamics sheds light on the origin of (genetic) information as a powerful mechanism to increase energy transduction." (2008, pg 2068). This biochemical example clearly points to complex informational states of affairs, in this case evolving genetic information as embodying highly effective entropy increasing mechanisms. Successful organisms are the ones that are able to adapt to and exploit their environment rapidly using available energy thereby accelerating entropy. Under Floridi's ontocentric principles, it seems we are doomed; as highly successful entropy generating organisms we ought to remove ourselves *qua* information objects from the infosphere.

The corollary is this: increases in the semantic richness of content, informational complexity and meaning within the infosphere with regard to objects or states of affairs *qua* information objects at an informational LoA necessarily results in an entropy cost elsewhere. That entropy cost can be seen at the informational LoA but has its analogous interpretation at materialist LoA. All costs can ultimately be sheeted back to an energy conversion cost, a resulting energy loss via dissipated heat, necessarily resulting in an entropy increase toward a state of equilibrium. This has its informational LoA equivalent; all informational costs can be ultimately sheeted back to informational conversion costs.

Solving the Entropy Problem in IE

In order to solve this problem, I believe we need to develop an *informational* story about how moral decisions are to be made. We must first recognise that any increase in entropy at a physical/materialist LoA has its counterpart at the informational LoA. I don't see this as being problematic for IE in anyway, after all as Floridi has pointed out H_2O is conceived of as a chemical object at the chemical LoA, and has as its counterpart "water" at an ELoA (Floridi, 2012, p269). They are essentially the same thing just considered at different LoA. Acceptance of this is critical in that it acknowledges that increases in semantic complexity necessarily come at some (entropic) cost. Further it entails more or less explicit relationships or mappings (or correspondences) between differing levels of abstraction. I think we have seen enough evidence to suggest that this is indeed the case. Certainly to deny it I suggest means that we must accept a version of "entropy" which bears no relation the general meaning of the concept but more worryingly, it potentially obfuscates any discussion that makes use of the term. We also must agree that almost all activity that results in an increase in complexity including the maintenance of our internal order as living organisms, returns an corresponding amount of energy plus entropy and so any movement to prevent, let alone utterly eliminate entropy is untenable. Indeed Floridi acknowledges that any goal to eliminate the kind of entropy described by the theory of thermodynamics wouldn't simply be controversial but idiotic. I couldn't agree more.

Yet if claim that informational entropy is vastly different to a materialist reading of entropy we end up with a paradox that requires considerable explanation or worse the *ad hoc* application of IE's principles on a case by case basis based upon our judgement calls about the intrinsic worth (minimal and perhaps overidable) or whether or not we ought to offer moral respect to all manner of information objects and these decisions will almost certainly have to be made at an everyday LoA. The problem for this approach as previously discussed is that it appears to force IE into making consequentialist based claims about which set of circumstances we can live with and which set we are not prepared to

tolerate. Ultimately such judgements as we have seen typically appeal to principles not directly related to IE's ontocentric principles but instead to other norms or prearranged rules depending upon the context of the decision. Consequently this approach does not appear to solve the foundational problem which IE was originally intended to address. The corollary is that we must accept as incoherent any claims implied or explicit that 'entropy may be decreasing at an informational LoA while it is increasing at a physical LoA within the same system'. *Prima facie* any increase in semantic complexity will incur an increase in entropy somewhere.

Biological explanations of entropy as we have seen argue that increases in complexity are the result of energy use in exchange for increases in entropy and heat exchange. At an informational LoA I see this as being no different – all increases in informational complexity are necessarily the result of energy use (interpreted from an informational LoA). Seeing informational entropy in this light brings it into line with other accepted explanations and also helps establish clear mappings or correspondences between differing LoA. Adopting this approach I believe strengthens the coherency of IE and the method of LoA. It does however create a new problem. It acknowledges that the there will now be a great deal of activity that violates Floridi's four universal laws or ontocentric principles, that is, that information entropy ought not to be caused, be prevented and or removed.

Floridi, in response to Brey's 2008 critique of IE offers us some direction regarding this problem. Recall that IE maintains that "non-sentient entities have some minimal, easily overideable but still intrinsic value" (Floridi, 2008). The burden of proof Floridi suggests is to ask "from a patient-oriented perspective whether there is anything in the universe that is intrinsically and positively worthless ethically and hence rightly disrespectable" (*ibid*). In reference to IE's ontocentric principles we might argue that any informational entity or constituent state of affairs that causes or contributes to entropy qualifies as an entity whose intrinsic value is minimal and overridable. Such entities or states of affairs as per the ontocentric principles ought to at least be minimised, if not removed from the infosphere.

Thus an objective approach I believe is to remain true to the principles themselves and thereby avoid some of the claims that IE collapses into a form of consequentialism. The consequentialist commitment to maximisation of the good is not necessarily guaranteed. While we acknowledge our own existence as intelligent sentient beings carries a high degree of intrinsic worth and the maintenance of our well being and general

existence entails entropy increasing activity, judgement calls between activities and behaviours based upon entropy generation are still able to be made.

This view is highly compatible with eco and biocentric ethical theories but extends to the inclusion of all including non-sentient or living entities as well as being inclusive of systems and states of affairs. In the new version (IE), the argument defends the intrinsic value and moral respectability of systems, non-sentient entities as well as individuals *qua* informational entities. (Floridi, 2002, pg 300). In consideration of "systems" or the infosphere as a whole, we are now able to balance certain activities or behaviours with levels of entropy generation that they may cause. Our approach is one of stewardship towards the infosphere so for example IE would counsel us against building a coal fired power generation facility in favour of the use of solar or wind power, but only where the entropy equation adds up.

Conclusion

This paper has considered in detail Floridi's use of the concept of Entropy within Information Ethics. An argument has been forwarded that Floridi's use of the concept of entropy is problematic in that it appears to allow for situations where entropy can be increasing at a physical LoA while informational entropy may be decreasing at the informational LoA.

I have argued that this approach results in difficult to resolve paradoxes for IE. The solution I propose is that we reconcile our discussions about entropy to bring them into line with more conventional approaches to the concept and I presented several lines of evidence to support this argument. Failure to do so results in IE collapsing into varying forms of consequentialist arguments about sets of consequences we can tolerate and those we cannot.

The approached forwarded I believe avoids some of the earlier criticisms directed towards IE and rightly applies an informational or ontological framework towards moral decision making. This approach also helps eliminate confusions regarding which level of abstraction moral decisions are made at. By adhering to the ontocentric principles we take a more objective look at moral dilemmas. This approach does not in any way attempt to do away with more orthodox ethical frameworks, IE never had that intention anyway. The idea is to extend the moral base to include all informational entities including non-sentient organisms and entities right through complex ecosystems and societies.

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