Neocybernetics, a critique

Introduction

Hyötyniemi (2006) in Neocybernetics in Biological Systems is advocating the use of multivariate statistical mathematics to study complex systems that so far have defied analysis due to their complexity.[1] Hyötyniemi proposes a neocybernetic approach where cybernetics is updated with the idea of emergence. This is a bold and necessary move, one that is a first start to begin to tackle new problems that are finally showing up on our horizon. Like, for instance, the need within artificial intelligence research for computers and robots that program or build themselves for so far any ascribed intelligence is only a compliment to the builder or programmer. It has been suggested that a neocybernetic approach with its important ideas about emergence is a promising avenue for further research.[2] So any work on neocybernetics is praiseworthy. At the same time it also makes it more important to be critical.

Neocybernetics in Biological Systems really is an attempt to show what wonderful things we might do once we take the neocybernetic path and start using multivariate statistical mathematics. It tries to persuade us to see the light and spend more time and research on neocybernetics. Why is persuasion needed? No doubt the mathematics stand on its own. The real questions here are why would we want to work with simplified, highly abstract models and how do these neocybernetic models connect with reality. Hyötyniemi is looking for a justification for this project and feels that he is justified by providing a philosophical framework for neocybernetics:

"As it turns out, many of the neocybernetic issues have a more or less philosophical dimension. Without concrete grounding, such discussions are hollow and void and they lack credibility."[3]

The aim of this paper is to discuss three major flaws in this line of reasoning. These flaws have no impact on the main thrust of neocybernetics. They are problematic for for the justification though. In short they are the use of frequentist statistics rather than Bayesian statistics, the essentialist nature of the philosophical framework and the use of semantics. All three flaws can be repaired. Repairing the argument thus will strenghten the case for neocybernetics considerably because in doing so it will also solve many minor objections that creeped as a result of using frequentisme, essentialism and semantics. The stategy will be to first show off the good that neocybernetics might accomplish. Then show the two major weaknesses in the approach given by Hyötyniemi. And finally it will be shown how these weaknesses can be overcome and repaired and how that strengthens the case for neocybernetics.

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[1] Hyötyniemi, Heikki (2006) - Neocybernetics in Biological Systems, report 151 Helsinki University of Technology Control Engineering Laboratory http://neocybernetics.com/report151/

[2] Van der Zant, Tijn (2010) - Generative AI: a neo-cybernetic analysis, dissertation Rijksuniversiteit Groningen

[3] Hyötyniemi (2006) p. 20

Cybernetics

The term “cybernetics” has been coined by Wiener (1948).[4] It has been popularized in modern terms like “cyberspace” and “cyborgs”. it is the culmination of a research program to find ways of computing stuff that is hard to do for humans, like calculating the path of a enemy warplane that needs to be shot down. Wiener’s approach was more organic than Turing’s approach who is the godfather of the digital general purpose computer. A good example of an organic approach to computing is the Cockroach-Controlled Robot, where you have a robot that moves through a room like many digital robots but all the calculations are done by a cockroach.[5] Even though cybernetics “lost” the battle for the computer and almost everyone is working the Turing’s digital computer nowadays, cybernetics has been such a success that it has given birth to the field of cognitive science. But this success has it’s darker side. With the rise of cognitive science the focus on control and communications has been lessened in favor of a focus on cognition. Of course cognition plays an important role within control and communications, but putting cognition before control and communication steers the whole research project into a completely different direction. A direction where cognitive psychology plays a much, much bigger role and one that with hindsight might have been less favorable than originally thought. With the lack of any landmark breakthroughs the appeal of cognitive science starts to wane ever so little and the first cries for a revitalized cybernetics, neocybernetics, can be heard.

What is need to advance is the study of complex system. According to Hyötyniemi General System Theory *“can easily become too holistic without concrete grounding”*[6] and computationalism might have chaotic iterations without any correspondence with reality. What is needed is not new science but a new interpretation of established mathematics. Neocybernetics views complex systems in terms of feedback and emergence. Elementary particles give rise to individual atoms. Groups of atoms form and out of them emerges macroscopic entities who than can be studied in large volumes where there will be attributes or properties not found on a previous level nor can there be a reduction of these properties or attributes to a lower level. Temperature cannot be described in terms of elementary particles.

Neocybernetics has four key ideas. First is the idea of dynamic balance where complex systems have attractors that create stability within a complex system. This stability is dynamic as the complex system has elasticity and tension so that it moves between different stable states. The second idea is that of environment-orientedness as no cybernetic system can exist in isolation. The third idea is high dimensionality where structural complexity is replaced by dimensional complexity. The final and fourth idea is simplicity where simple complex systems can be used as an analogy for complex complex systems.

Out of these four ideas we get a bunch of very nice emerging results. For one you can show how complex systems can become goal seeking by showing that:

“No matter what is the physical manifestation of the environmental variables, a surviving system interprets them as resources, and exploits them as efficiently as possible.”[7]

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[4] Wiener, Norbert (1948) Cybernetics or control and communication in the animal and the machine

[5] Pickering, Andrew (2009) Beyond design, cybernetics, biological computers and hylozoism, Synthese 168:469-491

[6] Hyötyniemi (2006) p. 9

[7] Hyötyniemi (2006), p. 69

That allows us to move from individuals to populations:

"The key point is that following the neocybernetic model there is evolutionary advantage. It turns out that optimality in terms of resource usage is reached, meaning that surviving, successfully competing natural populations assumedly must have adopted this strategy."[8]

And from resources to information:

"It is assumed that in a long run an evolutionary surviving system exploits all information it can see: being capable of efficiently exploiting the resources is a prerequisite of surviving in an environment, successful systems are the most active in acquiring for more and more information."[9]

Then if we are able to show how pure information ties back into biological systems as it must do somehow, we get wonderful stuff like:

"When signals are not existing purely in the infosphere but also, for example, in the chemosphere, a tight web of connections to the environment is constructed, constituting a grounding of "self". If associations become reconnected, the contents of the feelings can also change - neuro-linguistic programming (NLP) can truly change the way we see the world."[10]

So there is every reason to justify a research program into neocybernetics. Unfortunately, the justification as given by Hyötyniemi runs into three major problems: the use of frequentism, essentialism and semantics.

Frequentism

First of we start with Hyötyniemi's use of frequentism as this can be introduced through a more technical point leading to more fundamental philosophical issues. Frequentism is the school in statistical thought that sees probability as the frequency of favorable cases in the total number of trails. Frequentism is fatally flawed because it is based upon a circular definition of probability due to the trails in the definition of probability being defined as equally probable.[11] Cybernetics has always made use of frequentism so this is no fault of Hyötyniemi.[12] Nor is it limited to cybernetics. Almost all practitioners of statistics use frequentism. It is only within the philosophy of statistics that almost every philosopher rejects frequentism as fatally flawed. As often happens everyone doing practical work is just completely ignoring these uniquely unanimous findings of philosophers. Hyötyniemi is undeniable using the frequentist interpretation of statistics with his reliance on regression and the total least squares method.[13]

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[8] Hyötyniemi (2006), p. 94

[9] Hyötyniemi (2006), p. 122

[10] Hyötyniemi (2006), p. 174

[11] For a non-Bayesian fatal criticism of frequency, see Royall, Richard (1997) - Statistical Evidence, A Likelihood Paradigm, Chapman & Hall

[12] See for instance Ashby's (1957) reliance on the work of Fischer in Ashy, W. Ross (1957) AN INTRODUCTION TO CYBERNETICS

[13] Hyötyniemi (2006), p. 53-54 For a thorough criticism of regression and the total least squares method, see Howson Colin and Urbach, Peter (2003) - Scientific Inference, The Bayesian Approach

The darling of all those philosophers is Bayesian statistics. The big difference between Bayesianism and frequentism is how they interpret what statistics is about. Frequentism holds, wrongly, that events have a probability. Hence frequentists say things like “the probability of a fair coin coming up heads is 50%”. For frequentists probability is a feature a the world. Not so, say Bayesianism, events either occur or they don’t. Probability has nothing to do with the world, but only about our lack of knowledge about what has occurred or what will occur. As your and my state of information will differ, your and my probabilities will also differ. Given everything you know, you give prior probabilities to your personal evaluation of the results of unknown events. I do the same and as our state of information differs our probabilities differ. Once new information becomes known to you, you use Bayesian update rules to update your prior probabilities to your new posterior probabilities.

Bayesianism is a radical science which explains why the adaptation of Bayesianism in the day to day scientific practice has been so little. But so is cybernetics, let alone neocybernetics. On face value it seems that these two endeavors better join up and fight together. The most radical, but also the most correct version of Bayesianism, is de Finetti’s personal subjective Bayesianism that just wholly accepts that your and my probabilities differ, unlike some other, inferior versions of Bayesianism that try to weasel out of this conclusion in one way or the other.[14] Because probabilities differ de Finetti’s subjective Bayesianism has been hard to swallow for the scientific community. Hyötyniemi expresses a distrust of postmodern ironic science where relativism justifies every possible interpretation. It might seem that subjective Bayesianism travels just that path but this is not the case.

Even though you have complete freedom within subjective Bayesianism to come up with whatever prior evaluation of probabilities you want, not every possible evaluation is rational to make. Out of all the possible evaluations there is only a much smaller subset that contains all possible evaluations that are also coherent. Coherence is the major theme of Bayesianism. for Bayesianism statistics is a normative science that tells you how you must choose your evaluations if you want to be rational. It is a decision theory that shows that your decisions must be based upon a coherent evaluation of all relevant probabilities. Coherence is defined here as not making a decision if there is another decision that in all cases gets better or less worse results as the original decision.

This can be best understood by taking the idea of betting. The case is that you need to bet on all of your opinions about everything that is not known to you for certain. You are allowed to set up the bets in such a way that you decide on the probability and price of the bet, but that your opponent may choose which side of the bet to take. De Finetti argues convincingly that the only way to make sure that you do not lose the bet automatically is to make sure that all bets are balanced evenly. This is best seen as a scale where you can setup the turning point of the beam holding all the weights of all your opinions. The opponent gets to choose which side the scale will fall. The only way to make sure that you have a chance of winning is to set up the scale in such a way that the scale is in perfect balance and your opponent doesn’t get any information as to how the scale will fall just from the way you set up the scale.

So even while subjective Bayesianism accepts that interpretations might differ from each other, it has a normative structure to rule out certain interpretations as incoherent. It is exactly this ruling out of interpretations that both de Finetti and Hyötyniemi see as hallmark feature of science. Furthermore, once you have set your prior probabilities any new information

[14] De Finetti, Bruno (1970) Theory of Probability volume 1 & 2, Wiley

that comes to light influences your probabilities according to strict mathematical rules. It is taken that for most cases when individual scientists keep on updating their personal and subjective probabilities that they will converge to a position that is quite similar. Something very much along the same line of a stable attractor in neocybernetic terms. As we will see using Bayesian statistical interpretation of multivariate statistical mathematics will strengthen the case of neocybernetics while using neocybernetics concepts within the subjective Bayesian interpretation of statistics might strengthen the subjective Bayesian position as well. For indeed, how wonderful wouldn't it be if one could prove with neocybernetics that the population of scientists is complex system that has a dynamic balance between Kuhnian normal and revolutionary science in the form of stable attractors that coincide with the convergence of subjective Bayesian evaluations of each individual scientist. Talk about emergent properties!

For neocybernetics to have de Finetti on your side is a good defense against conservative scientific opinion:

"There are two common fallacies which deserve special mention. One consists in believing that a theory can be disproved merely by discrediting some particular explanation, consequence, or application of it. This is not so: it may well be the case that the particular explanation is not essential, or that the particular application breaks down for some other reason. The cursory manner in which new ideas are discussed is to be deplored, because such ideas, even though they may turn out to be false trails, usually contain within them the germ of something fruitful. In this respect the second of the two fallacies is even more dangerous. This fallacy consists of leaving out of consideration certain of the data or observations. In the logic of certainty this is quite legitimate: it is perfectly proper to start from some restricted set of hypotheses and to deduce the corresponding restricted set of conclusions (which are, in any case, correct). In the logic of probability this is not so …"[15]

This is the most important contribution of de Finetti, to distinguish the logic of probability, or as de Finetti aptly calls it: the logic of uncertainty, from the logic of certainty. Truth is only part of the domain of the logic of certainty. In the logic of uncertainty there are only individual subjective evaluations of probability that lie between 0% and 100%. Please note 0% here only means "judged to be very very improbable" and not "false", and 100% here means "judged to be very very probable" and not true. Besides the circular definition of probability, the other big mistake frequentism makes is to deal with uncertainty with the logic of certainty which is a category mistake. By using frequentism Hyötyniemi also treats, as we will see, uncertainty as if it were certain. Again this mistake is understandable in the light of the dominance of frequentism in every practical field to the point where practitioners are unaware that frequentism is a school of thought and that there are more viable alternatives.

Neocybernetics can definitely be improved with Bayesian statistics. All the tools like linearity, higher dimensionality and entropy that Hyötyniemi needs for neocybernetics are already have a developed Bayesian version. The frequentism versus Bayesianism debate is more about the interpretation of statistics than the math. In fact, unlike most critics of Bayesianism think, it is perfectly okay to introduce knowledge of a certain repeating pattern (i.e. a frequency) as information for establishing Bayesian priors or, in case knowledge of a new pattern comes to light, as input for Bayesian updating rules. So while there is a huge task for neocybernetics to learn more about subjective Bayesianism and double check all the math to see if it needs a little tweak here or there, this is all very doable practical stuff. Of course Hyötyniemi already mentions Bayesian networks and Markov models and remarks that the former needs the

[15] De Finetti (1970) Volume 2 p. 196

assumption of independence and the latter needs to explicitly resolve causality structures. Not so in the case of subjective Bayesianism. De Finetti is very critical of the frequentist notion of independence and has done a lot of work on depence. The same goes for Markov Chains. Furthermore de Finetti, as we will see later on, has no need for resolving the causality structures. Again neocybernetics and subjective Bayesianism seems a match made in heaven.

Even more interesting is using the Bayesian viewpoint as a way to create a more coherent interpretation of neocybernetics. For instance an analogy between neocybernetic dynamical balances as attractors and de Finetti's interpretation of probability as the barycentre of mass. Evaluations within memetic systems as de Finetti's proper scoring rules.[16] The culminating life experience of neocybernetics and learning by experience with Bayesian updating rules. The black box approach of cybernetics with the non-sequential updating in de Finetti due to all new information that comes available not just the research data.

Most importantly, neocybernetics can stop making the category mistake of treating uncertain things as certain by employing the logic of uncertainty coherently throughout the theory. That means replacing all prediction (which takes an uncertainty and tries to make it certain) with prevision. Simulation of the future environment taken as prevision rather than prediction keeps neocybernetics nicely within the confinements of the logic if uncertainty. A prevision of the future also makes it much easier to understand why the concept of a mental image can be of use here. Or why the unknown future acts the same as an unknown past. Furthermore there is no more need for limit theory and infinity and all the paradoxes of getting any result you want that comes with those two. De Finetti shows how all can be done with simple additivity.[17]

Furthermore it would bring neocybernetics in line with what is now publicly perceived as the best in artificial intelligence: IBM's Watson computer that won Jeopardy beating two of the best human Jeopardy players on the planet. Watson won by using subjective Bayesianism. For subjective Bayesianism is ideal for digital computers. Ultimaly the central processing unit (CPU) (or one out of many in case of parallel processing) needs to take the decision, in the case of playing Jeopardy to give the original question for the given answer. All the knowledge in its database and all the "domain semantics" programmed into his code is unknown to the CPU upon till the moment that specific information reaches the CPU. When that is the case the CPU can use that information to update his prior probabilities. Precisely because digital computers are so sequential Bayesianism works wonders with computers. If Hyötyniemi prefers:

"Perhaps one should look at the cybernetic models more like methods towards implementing sophisticated data mining and process monitoring, perhaps better matching and supporting mental views of human experts than wat the traditional statistical tools can do."[18]

joining hand with subjective Bayesianism seems to be the way forward. The environment-orientedness of neocybernetics is at the core of subjective Bayesianism. Updating your prior probabilities means updating them in the light of all new information you have received from the environment not just a new piece of relevant research data. In order to keep your subjective opinions coherent almost all new information influences your prior probabilities somehow. The influence might be very very small, yet even a small influence is a influence after all.

The need for Bayesian statistics is foreshadowed by Hyötyniemi when he wrote:

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[16] de Finetti, Bruno (2010) - Philosophical Lectures on Probability, Synthese Library 340 Springer

[17] idem p. 116

[18] Hyötyniemi (2006) p. 131

"There will never exist a complete world model as the model is relative to the observer and observations. How the potential becomes actual and in which form - or in other terms, determination of the features that are used to characterize the system."[19]

In other words because knowledge of observations is always situated in a particular observer there can be no complete prevision of the future world. There are only subjective and personal previsions that differ due to differences in what is observed or not. To conclude: there can only be neocybernetics if it switches from frequentism to subjective Bayesianism. Switching comes at a price though as de Finetti writes:

"In the philosophical arena, the problem of induction, it's meaning, use and justification, has given rise to endless controversy, which, in the absence of an appropriate probabilistic framework, has inevitably been fruitless, leaving the major issues unresolved. It seems to me that the question was correctly formulated by Hume (if I interpret him correctly - others may disagree) and the pragmatists (of whom I particularly admire the work of Giovanni Vailati). However, the forces of reaction are always poised, armed with religious zeal, to defend holy obtuseness against the possibility of intelligent clarification. No sooner had Hume begun to prise apart the traditional edifice, then along came poor Kant in a desperate attempt to paper over the cracks and containing the inductive argument - like its deductive counterpart - firmly within the narrow confines of the logic of certainty."[20]

Hyötyniemi has been lured by the seductions of Kant to go beyond everything uncertain that frequentism takes as certain and claim even more metaphysical certainty where none exist. This is the second major flaw and in order to save and strengthen neocybernetics he need to give up on Kantian certainty as we will see in the next section.

Essentialism

One way to characterize essentialism is made famously by Quine:

"*[Aristolian essentialism] is the doctrine that some of the attributes of a thing (quite independently of the language in which the thing is referred to, if at all) may be essential to the thing, and others accidental.*"[21]

The problem with essentialism is that it depends on the object having properties without any form of reference. The point here is that that position might not be intelligibility. Throughout Neocybernetics in Biological Systems Hyötyniemi is looking for the essence of things though. Quoting Heraclitus:

"Everything changes, everything remains the same. Cells are replaced in an organ, staff changes in a company - still functions and essence therein remain the same."[22]

Hyötyniemi sees similarities in complex systems and thinks that a neocybernetics captures the

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[19] Hyötyniemi (2006) p. 248

[20] De Finetti (1970) volume 2 p. 201

[21] Quine, W., 1976, The Ways of Paradox and Other Essays (revised and enlarged edition), Harvard University Press. p. 173-174

[22] Hyötyniemi (2006) p. 7

essence of complex systems in emergence. Careful coding and analysis captures the essence of the domain field in data structures. Model and nature are closely linked:

"Also nature has no centralized master mind; is is facing the same optimization problems, seldom finding the strictly optimal solution: in this sense, the model over the local minima better captures the possible alternatives ans essence (remember Heraclitus: "You cannot step in the same river twice").

Because the system is optimized in a certain sense, the representations are (more or less) unique. The neocybernetic model is a "mirror image" of its environment, being itself a model of the environment, capturing relevant behavioral patterns manifested in data."[23]

The fine line between model and reality seems to be crossed as Hyötyniemi considers this more than just a metaphor.[24] Furthermore, the postmodern criticism of something being a mirror of nature is ignored while at the same time the Kuhnian framework for science is accepted.[25] That seems contradictory. Here are some more examples of crossing this boundary:

"It is assumed that in a system the data are somehow bound together, and it is this bond that captures the essence of the system."[26]

"The essence of evolution, or any developmental processes, can be represented as code - or anyway, different kinds of codes is the way how nature does it."[27]

"It has been said that models are 'out' - it has been always admitted that models cannot capture the essence of systems, but when studying complex systems in particular, it seems they cannot even capture the behaviors of them: in chaos theoretical models small deviations in initial conditions results in completely different outcomes. In neocybernetic models, however, stochastic variations are not significant. It is statistically relevant constructs or attractors of dynamic processes within the phenosphere that are being captured, and role of the transients fades away. As the approach is thus inverted, the emphasis being on balances, in the resulting emergent model one can capture not only the behaviors but also the essence."[28]

"Hegel can be seen as one of the first system theoreticians. Only the whole is consistent and a real thing, all partial explanations being illusory and deficient. Many of his thoughts can be interpreted in terms of cybernetic conceptes - essentially, Hegel is speaking of very complex agent-based emergent systems In the Heraclitus spirit, the essence is not being but becoming."[29]

In this last quote the contradiction in Neocybernetics in Biological Systems comes out the most clear. Becoming can never be an essence, especially not when contrasted with being. For the word "essence" comes from the latin root "esse" meaning to be. Thinking in terms of essence is

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[23] idem p. 19

[24] idem p. 119

[25] Rorty, Richard (1979) - Philosophy and the Mirror of Nature, Princeton University Press, Thirtieth-Anniversery Edition (2009)

[26] Hyötyniemi (2006) p. 45

[27] idem p. 198

[28] idem p. 244-245

[29] idem p. 108

hindering neocybernetics. As Nietzsche says:

"In short, the essence of a thing, too, is only opinion about the 'thing'. Or rather 'This is considered to be' is the real 'This is', the sole 'This is'."[30]

Such an attitude towards essence matches nicely with subjective Bayesianism where it all boils down to of making probability evaluations of your opinions. Looking out for essence is a mistake especially if one looks for it in the mirror of nature. And even more so if one finds it in mathematical models. That looks suspiciously like treating numbers as more than that they are. Again Nietzsche has a clear warning:

"What seperates me most deeply from the metaphysicians is: I don't concede that the 'I' is what thinks. Instead, I take the I itself to be a construction of thinking, of the same rank as 'matter', 'thing', 'substance', 'individual', 'purpose', 'number': in other words to be only a regulative fiction with the help of which a kind of constancy and thus 'knowability' is inserted into, invented into, a world of becoming."[31]

This quite postmodern position clearly shows the gains neocybernetics can make once it let go of essence. Models and systems is what our brain inserts into a world of becoming in order to gain constancy. Constancy sounding almost like dynamic stable attractors in neocybernetic terms. The impression is that nothing will be lost for neocybernetics once it gives up on essence and that there is a lot to be gained. Neocybernetics already has a great story about constructive systems, like the infosphere or the ideasphere, and how democracy is the most cybernetic political system.[32] Rather than work so hard in trying to explain how these high level informational system emerge from low level procecess, neocybernetics might prove much more powerful if it shows how both the high level structure and the low level structure that we humans perceive is a cybernetic construction of our mind. Rather than choosing between a top-down approach or a botton-up approach, go for man in the middle approach who can both chunk up towards higher levels and chunk down to lower levels with one and the same method: neocybernetic models. Rather than trying to find down below what made us created what's up there, it is better to find how we create what is down below just in the same manner as what we create up there.

This is especially the case of how Hyötyniemi handels causality. Neocybernetic models differ from causal models so here lies a problem for Hyötyniemi. He has a elegant but wrong solution called "pancausality" where each variable influences each and every other variable in the model. But "pancausality" is pseudo-concept as de Finetti would say. Either within a "pancausal" model there is real causality and then there is a normal sequential causal chain of how each variable influences all the other variables through time. Or these "causations" happen simultaneously and in that case we are unable to differentiate between cause and effect and hence have no cause and effect at all. Hyötyniemi wants both. For low level processes control engineering works with real casuality. In higher level models the time scale is compressed so that the little time between cause and effect is removed from the model and all causation happens simultaneously.[33]

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[30] Nietzsche, Friedrich (1886) - Writings from the Late Notebooks, Notebook 2, section 150 Cambridge University Press (2003)

[31] Nietzsche, Friedrich (1885) - Writings from the Late Notebooks, Notebook 35, section 35 Cambridge University Press (2003)

[32] Hyötyniemi (2006) p. 102-103

[33] idem p. 177-178

This approach is wrong if one accepts subjective Bayesian statistics as one ought to. De Finetti:

"As far as the use of the term 'hypotheses' for H is concerned, it should be unnecessary to point out that it refers only to the position of H in E|H (or in X|H), and that, apart from this, H is any event whatsoever. We say this merely to avoid any possible doubts deriving from memories of obsololete terminologies (like 'probability of the hypotheses' or even worse 'of the causes', a notion charged with metaphysical undertones."[34]

This refers to the discussion between frequentists who want to look into the conditional probability of P(H|E) which means the probability of the event of hypothesis given the data of a certain frequency, versus the Bayesian view of conditional probability of the prevision of P(E|H) which means your subjective probability evaluation of the result of an unknown event. What matters is de Finetti's careful rejection of the idea of causality as metaphysics and de Finetti doesn't like metaphysics:

"In order to give an effective meaning to a notion - not merely an appearance of such in a metaphysical-verbalistic sense - an operational definition is required. By this we mean a definition based on a criterion which allows us to measure it."[35]

Again this seems to be beautiful in line with the general jist of neocybernetics which its predominance of mathematics and measurements. Hyötyniemi seems to prefer to include metaphysics in neocybernetics. Or to phrase it more accurately: to show how neocybernetics can give us or help us reach metaphysics. It might be that going in the opposite direction proofs to be more useful and fruitful: using cybernetics to show that there is no need for metaphysics and that indeed the notion of causality is the wrong one and that a neocybernetic notion where one thing follows another is to be preferred. Nietzsche puts the point as follows:

"'Cause and effect' - In this mirror - and our intellect is a mirror - something is taking place that exhibits regularity, a certain thing always succeeds another certain thing - this we call, when we perceive it and want to call it something, cause and effect - we fools! As though we had here understood something or other, or could understand it! For we have seen nothing but pictures of 'causes and effects'! And it is precisely this pictorialness that makes impossible an insight into a
more essential connection than that of mere succession."[36]

It is not that we perceive causality because at some level there really is cause and effect, but we our experiencing of time mainly as mental images has been followed in humans by the tendency to express their strong feeling about these successions as cause and effect. One doesnt lose anything of value by removing cause and effect from the picture except that now we lack a way of expressing our strong feelings about these succesions. Nothing changes in the picture once cause and effect are removed. Rather than introducing "pancausality" neocybernetics is better of condemning hand in hand with de Finetti the use of causality.

Nevertheless Hyötyniemi has a strong need for strict causality in order to control engineering,

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[34] De Finetti (1970) volume 1 p. 139

[35] idem p. 76

[36] Nietzsche, Friedrich (1881) - Daybreak: Thoughts on the Prejudices of Morals section 121 Cambridge University Press (1997)

"when implementing control, it is strict causalities only that can be utilized."[37] It is even stronger than that:

"The complex causal structures are the main theoretical problem when striving for more active controls. Not all dependencies contributing in the outside world can be detected. - But, indeed, the complete structure of causalities is not needed. Note that the observed correlations can be utilized for prediction even though the underlying mechanisms are hidden. THere are different routes to the same end result and it suffices to identify the mechanisms of one's own actions to the future. This way, first mapping the observed current state to the future (applying observed correlations), and from there back to one's control actions (inverting the observed causalities), the general 'model predictive control' can be implemented, when seen in the control engineering perspective. To implement such a scheme, explicit prediction or anticipation of the future is necessary."[38]

In other words, in order to have control it is necessary to predict the future and counteract any potential cause for stuff that you don't want to happen. Here it is clear that Hyötyniemi is completely within the bounds of the logic of certainty for things that are uncertain. And again nothing is lost for control engineering once everything is put correctly in the logic of uncertainty. Once that is done, the same passage will read that in order to control for things that you don't want to happen it is necessary to make a prevision of the future. In case your prevision of the future includes any event with a high or very high probability evaluation you need to take action make sure that your probability evaluation of the event drops considerably. It is important to note here that while Hyötyniemi stresses control actions, these actions really start with a control decision that some kind of perceived threat has a too high probability evaluation. Once that decision has been made, all the actions flow almost automatically from that decision. Again subjective Bayesian decision theory matches greatly with neocybernetics.

So rather than having causes within subjective Bayesianism one has very high probability evaluations of unknown events. If someone throws a ball, I give a very high, for instance 100%, probability evaluation to the event that the ball at some point in time will drop back to the ground. There is no need for causation for all of my decisions and actions. The logic of uncertainty is more than enough.

There remains only one major question to answer according to Hyötyniemi: *"What is the essence of a system and how this essence should be interpreted?"* [39] His answer is "semantics". And this is the third and final major flaw in Neocybernetics in Biological Systems as we will see in the next section.

Semantics

"Semantics conveys meaning. Traditionally, it is thought that semantics cannot exist outside of the brain. However, to reach 'smart models' that can adept in new environments one needs to make this meaning machine-readable and machine-understandable. Otherwise, no abstraction of relevant vs. irrelevant phenomena can be automatically carried out. Indeed, one is facing a huge challenge here, but something can be done.

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[37] Hyötyniemi (2006) p. 183

[38] idem p. 183-184

[39] idem p. 43

For the purpose of concrete modelling, the notions of semantics has to be formalized in some way: this very abstract concept is given here very concrete contents, compromising between intuitions (what would be nice) and reality (what can be implemented in reality). It can even be said that a good model formalizes the semantics of the domain field, making it visible and compressing it. Now there are two levels of semantics to be captured:

1. Low-level semantics. The formless complexity of the underlying systems has to be captured in concrete homogeneous data. The "atoms" of semantics constitute the connection between the numeric representations and the physical ream, so that the properties of the system are appropriately coded and made visible to the higehr-level machineries. In concrete terms, one has to define 'probes' and put them in the system appropriately.

2. Higer-level semantics. The high number of structureless low-level features have to be connected into structures of semantics atoms. Assuming that the atomic semantics are available, this higher level task is simpler, being more generic, whereas finding representations for the low-level domain-area features is domain-specific."[40]

This long quote shows that it follows the early Wittgenstein of the Tractatus who thought of the world consisting of atomic facts that can be represented in atomic propositions. Here that idea is brought back to life with the idea that you can code these atomic propositions into atomic semantic blocks. It was the later Wittegenstein of the Philosophical Investigations who has showed himself that this view is fatally flawed for it misses a lot of ordinary language use. Even if atomic propositions weren't fatally flawed then we still wouldn't be able to code them into our current computers as atomic semantics. Just because something is readable for a machine doesn't make it semantically. Of course if the machine would understand what it read then surely one could speak of semantics but alas the machine doesn't understand anything at all. All what happens in our current computers is that one configuration of electrons flowing through silicon is rapidly followed by another configuration. The only thing we do with computers is to translate stuff that we understand in a computer readable form, have the computer change what it read in some way that is only significant for us (the computer couldn't care less) and then have the computer in some way present us the new result in such a way that we can read and understand the result. All the involved understanding is being done by us. So not only is the whole idea wrong but it can't be implemented in our current computers.

Fortunately, there might not be a need for such coding of semantics. What if semantics can exist outside of human brains, or to put it more strongly: what if our human semantics is already an emergent property of a linguistic community rather than an individual human being or a brain? One such a position has been proposed by Stich and is called "Syntactic Theory of Mind".[41] It has been widely criticised such that Stich himself doesn't even seem to support this position anymore and has moved on to connectionism.[42] But this may have been to hasty. There have been many criticisms of the Syntactic Theory of Mind, but one of the most prominent criticism came from Crane who tried to show that you can't have syntax with semantics.[43] Crane too builds his first major argument against the Syntactic Theory of Mind on an interpretation of the later Wittgenstein, but this interpretation can be shown to be wrong.[44]

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[40] idem p. 43-44

[41] Stich, Stephen (1983) - From Folk Psychology tot Cognitive Science The MIT Press p. 149-183

[42] Stich, Stephen (1996) - Deconstructing the Mind Oxford University Press

[43] Crane, Tim (1990) - The Language of Thought: No Syntax Without Semantics - Mind & Language Vol. 5 no 3. Autumn 1990

[44] Van der Leij, Joost (2011) - Mentale representatie van private sensaties unpublished.

In short the argument follows along the lines that if one accepts as the later Wittgenstein does that there is no private language possible then one cannot have a private semantics either. This also rules out an objective semantics independent from any intelligent agent (another reason why essentialism fails) because if there is an independent objective semantic than it would be possible for an individual to be the only person who got this right and base his private language on this independent objective semantic. It is precisely that no such independent criterion for semantics can be found that one is unable to create a private language for there is no way of independent justification for applying the private language correctly. Only a linguistic community can provide such an independent justification and does exactly that with a public language. If there were an independent semantic to be found the whole private language argument would collapse. That is the reason why Fodor argues so much against the private language argument.[45] For if it holds then his version of the language of thought fails as it in fact does.

Semantics is only part of a community that uses language. As long as people are able to function within the community they are taken to understand the semantics. Meaning is use in the language game a community plays. This semantics doesn't reside in the brain of any individual in the community, only the training or the instructions needed to be able to use the language of the community is coded in the brain. In neocybernetic terms any system that survives in a population that plays a language game and that is able to function within that population must have been trained in the correct use of the language. This training is coded into the system not the semantics. The semantics only function as an emergent property of the community taken as a system. There is no need for computers to domain semantics being coded into them. The only thing what is needed is to be able to follow the rules being played in the language game.

That is the reason why chess computers appear so intelligent to us. It has nothing to do with any inherent intelligent of the machine or the code. It has only to do with the fact that these chess computers follow the rules of the chess language game. A chess player can communicate perfectly with a chess computer whenever he limits his communications to the rules of chess. There is no need for the machine to understand chess. All that is needed is that he follows the rules of chess. As long as the computer is playing correctly according to the rules it is part of the chess community. But as a chess computer breaks the rules of chess, it is taken out of the community because it is bugged and to be repaired before it can join the chess community again. This in a complete analogy with what our society at large does with crazy people who are unable to follow our most basic rules. We declare them bugged and put them in a seperated place to be repaired. Or in social language: we declare them to be mentally ill and the need to be cured before they can be a part of our community again.

Crane's second argument against the Syntactic Theory of Mind is that if it is only syntaxis that counts that we would have to conclude that the British railway system has a mind as it consists of a system moving along certain syntactic rules. For most people this sound as a sound argument, but not for cybernetics! For it is exactly this taking man and machine as systems for control and communications that distinguishes cybernetics from other sciences. It ought to be quite easy for neocybernetics to show that the British railway system indeed has mindlike properties once you look at it as a complex system and at the same time neocybernetics ought to easily show that in terms of complexity the brain is much more of a complex complex system while the railway system is more of a simple complex system so that the differences can be

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[45] Fodor, Jerry A. (1975). The Language of Thought, Cambridge, Massachusetts: Harvard University Press

easily explained in neocybernetics terms. With both of Crane's arguments removed the way is clear for neocybernetics to make use of the Syntactic Theory of Mind or some neocybernetic version of it as there are still some other more technical problems with the Syntactic Theory of Mind.[46]

Hyötyniemi fears Chinese room arguments:[47]

"A cognitive model is void, its essence escapes, giving rise to Chinese room type arguments, if it does not somehow capture the semantics of the constructs. One needs to extend from the infosphere, where it was simply data (co)variation that need to be captured, to 'ideasphere'."[48]

For one thing the approach of atomic semantics Hyötyniemi proposes doesn't seem to avoid Chinese room arguments. But with the later Wittgenstein there might not be a need to avoid Chines room arguments. One can think of Wittgensteinian language game where a person is ordered to go out and buy five green apples either by pointing to the color green as remembered and counting out the letters of the alphabet for each green apple and stopping at after "e", or by handing someone five green cards and ordering him to bring an apple of the same color for each card. For Wittgenstein both cases or correct uses of language within that particular language game. The latter version doesn't seem to differ in any relevant way from a Chinese room argument and still this makes no difference to Wittgenstein. The person in question knows how to use the language coded in the green cards and functions as a member of the community playing that particular language game. Chinese room arguments may well work against claiming artificial intelligence but fail in this respect as it comes to artificial semantics if you want to call it that.

Conclusions

To conclude we have seen three major flaws in the philosophical justification of neocybernetics: the use of frequentism, essentialism and semantics. Fortunately, all three flaws can be repaired by replacing frequentism by subjective Bayesianism, give up on essentialism and regard semantics as an emergent property of a linguistic community. In doing so neocybernetics is strengthened considerably because subjective Bayesianism matches quite good with neocybernetics. Nothing is lost by giving up on essentialism and a lot is gained by moving semantics up on the ladder to an emergent property of linguistic communities.

These moves make an already controversial science like cybernetics even more revolutionary. As every revolution needs its own guerrilla army, the only thing left to do is to join forces and start spreading this new way of doing science across the globe. Hyötyniemi has put out his Neocybernetics in Biological Systems as a neocyberntic probe on the internet to see if it the text will function as a stable attractor of like minded people. It has been the inspiration for this critique. It is important to stress that even with this critique the main thrust of what Hyötyniemi tries to achieve with neocybernetics is fully supported. Even though neocybernetics will adapt in

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[46] Aydede, Murat (2005) - Computation and functionalisme: syntactic theory of mind revisited. Turkish Studies in the History and Philosophy of Science pagina 177-204 - Ayede argues that at least a Syntactic Theory of Mind must be holistic, must go beyond mere statistical summaries and must be lawlike. All these requirements ought to be deliverable by neocybernetics.

[47] Searle, John (1980) - Minds, Brains and Programs in Behavorial and Brain Sciences, vol 3. pp. 417-424

[48] Hyötyniemi (2006) p. 169

the future, it is definitely the way forward. Hyötyniemi has listed ten levels where neocybernetics has something interesting to say, from the very low level subcell activity to high level of reality as a whole.

Yet there is more to neocybernetics than listed by Hyötyniemi. For one strong artificial intelligence is needed in order to run conscious simulation of ourselves, the best way to reach immortality. It has been predicted that within thirty years our current digital computers can simulations of us that other people cannot distinguish from real people and thus fulfilling the Turing test.[49] But this something completely different from having a computer running a simulation of you or me that is conscious. For it has been shown that there is no difference between you and a conscious computer simulation that thinks it is you.[50] One can say with a high probability evaluation that our current computes won't be conscious within thirty years and that we need new breakthroughs in order to get even close. Breakthroughs that can only come from revolutionary sciences like neocybernetics. So if this paper has somehow gotten your attention through the ideasphere you are more than invited to join forces and see how we can advance neocybernetics more rapidly.

[49] Kurzweil, Raymond (2005) - The Singularity, Viking Press

[50] Parfit, Derek (1984) - Reasons and Persons, Oxford University Press